Canada Parliament
Sessional papers

SESSIONAL PAPERS

VOLUME 13

FOURTH SESSION OF THE TENTH PARLIAMENT

OF THE

DOMINION OF CANADA

SESSION 1907-8

VOLUME XLII

See also Numerical List Page 5.

ALPHABETICAL INDEX

TO THE

SESSIONAL PAPERS

OF THE

PARLIAMENT OF CANADA

FOURTH SESSION, TENTH PARLIAMENT, 1907-8

See also Alphabetical Index, page 1.

LIST OF SESSIONAL PAPERS

Arranged in Numerical Order, with their titles at full length; the dates when Ordered and when Presented to the Houses of Parliament; the Name of the Senator or Member who moved for each Sessional Paper, and whether it is ordered to be Printed or Not Printed.

CONTENTS OF VOLUME 1.

(This volume is bound in two parts.)

1. Report of the Auditor General for the nine months ended 31st March, 1907. Partial report presented 28th November, 1907, by Hon. W. S. Fielding; also 2nd December and 17th December .. ..*Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 2.

2. Public Accounts of Canada, for the fiscal period of nine months ended 31st March, 1907. Presented 28th November, 1907, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

3. Estimates of the sums required for the services of Canada for the year ending 31st March, 1909. Presented 11th December, 1907, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

3a. Further Supplementary Estimates for the year ending 31st March, 1909. Presented 9th July, 1908, by Hon. W. S. Fielding...*Printed for both distribution and sessional papers.*

4. Supplementary Estimates for the twelve months ending 31st March, 1908. Presented 3rd February, 1908, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

4a. Supplementary Estimates for the year ended 31st March, 1908. Presented 16th March, 1908, by Hon. W. S. Fielding... .. ..*Printed for both distribution and sessional papers.*

5. (No issue.)

6. List of Shareholders in the Chartered Banks of Canada, as on the 31st December, 1907. Presented 8th May, 1908, by Hon. S. A. Fisher.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 3.

7. Report of dividends remaining unpaid, unclaimed balances and unpaid drafts and bills of exchange in Chartered Banks of Canada, for five years and upwards, prior to 31st December, 1907. Presented 29th June, 1908, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 4.

8. Report of the Superintendent of Insurance for the year ended 31st December, 1907.
Printed for both distribution and sessional papers.

9. Abstract of Statements of Insurance Companies in Canada, for the year ended 31st December, 1907. Presented 14th May, 1908, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 5.

10. Report of the Department of Trade and Commerce, for the fiscal year (nine months) ended 31st March, 1907. Part I.—Canadian Trade. Presented 29th November, 1907, by Hon. W. S. Fielding. Part II.—Trade of Foreign Countries and Treaties and Conventions. Presented 11th March, by Hon. W. Paterson.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 6.

10*a*. Convention respecting the Commercial Relations between France and Canada, entered into at Paris on the 19th day of September, 1907, between His Majesty and the President of the French Republic. Presented 28th November, 1907, by Hon. W. S. Fielding.
Printed for both distribution and sessional papers.

10*b*. Correspondence and memoranda in connection with the Convention of 1907, respecting the commercial relations between France and Canada. Presented 9th January. 1908, by Hon. W. S. Fielding.. .. ..*Printed for both distribution and sessional papers.*

10*c*. Supplement to Report of Department of Trade and Commerce, with statistics showing steamship traffic, &c. Presented 17th March, 1908, by Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

11. Tables of the Trade and Navigation of Canada, for the nine months of the fiscal year ended 31st March, 1907. Presented 2nd December, 1907, by Hon. W. Paterson.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 7.

12. Inland Revenues of Canada. Excise, &c., for the nine months ended 31st March, 1907. Presented 28th November, 1907, by Hon. W. Templeman.
Printed for both distribution and sessional papers.

13. Inspection of Weights, Measures, Gas and Electric Light, for the nine months ended 31st March, 1907. Presented 28th November, 1907, by Hon. W. Templeman.
Printed for both distribution and sessional papers.

14. Report on Adulteration of Food, for the nine months ended 31st March, 1907. Presented 28th November, 1907, by Hon. W. Templeman.
Printed for both distribution and sessional papers.

15. Report of the Minister of Agriculture, for the year ended 31st March. 1907. Presented 2nd December, 1907, by Hon. S. A. Fisher.
Printed for both distribution and sessional papers.

15*a*. Report of the Dairy and Cold Storage Commissioner for the year ending 31st March, 1907. Presented 10th February, 1908, by Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 8.

16. Report of the Directors and Officers of the Experimental Farms for 1906. Presented 10th January, 1908, by Hon. S. A. Fisher.
Printed for both distribution and sessional papers.

17. Criminal Statistics for the year ended 30th September, 1907.
Printed for both distribution and sessional papers.

17*a*. Census of Population and Agriculture of the Northwest Provinces: Manitoba, Saskatchewan and Alberta, 1906. Presented 18th February, 1908, by Hon. S. A. Fisher. *See 17a, 1907.*

17*b*. Return of By-Elections for the House of Commons of Canada, held during the year 1907. Presented 6th March, 1908, by Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

18. Canadian Archives. *See No. 15, page lv.*

CONTENTS OF VOLUME 9.

19. Report of the Minister of Public Works, for the fiscal period ended 31st March, 1907. Presented 2nd December. 1907, by Hon. W. Pugsley.
Printed for both distribution and sessional papers.

19a. Georgian Bay Ship Canal Survey. Report on the Precise Levelling; from 1904 to 1907. Published by the Department of Public Works.
Printed for both distribution and sessional papers.

19b. Progress Report of the International Waterways Commission. Supplementary Report to 31st December, 1907. Presented 5th June, 1908, by Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

19c. Supplementary Report of the International Waterways Commission, 1908.
Printed for both distribution and sessional papers.

20. Report of the Department of Railways and Canals, for the fiscal period from 1st July, 1906, to 31st March, 1907. Presented 29th November, 1907, by Hon. G. P. Graham.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 10.

20a. Canal Statistics for the season of navigation, 1906.
Printed for both distribution and sessional papers.

20b. Railway Statistics of Canada for the year ended 30th June, 1907. Presented 16th January, 1908, by Hon. G. P. Graham. *Printed for both distribution and sessional papers.*

20c. Second Report of the Board of Railway Commissioners for Canada, 1st April, 1906, to 31st March, 1907. Presented 29th November, 1907, by Hon. G. P. Graham.
Printed for both distribution and sessional papers.

21. Report of the Department of Marine and Fisheries (Marine) for 1907. Presented 18th December, 1907, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

21a. Seventh Report of the Geographic Board of Canada, 1907-8.
Printed for both distribution and sessional papers.

21b. List of Shipping issued by the Department of Marine and Fisheries, being a list of vessels on the registry books of Canada, on the 31st December, 1907. Presented 24th June, 1908, by Hon. L. P. Brodeur... *Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 11.

21c. Report on British and Continental Ports, with a view to the development of the port of Montreal and Canadian transportation.
Printed for both distribution and sessional papers.

22. Report of the Department of Marine and Fisheries (Fisheries) for 1907. Presented 18th December, 1907, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

23. Report of the Harbour Commissioners. &c.
Printed for both distribution and sessional papers.

23a. Report of the Chairman of the Board of Steamboat Inspection, 1907. Presented 27th February, 1908, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 12.

24. Report of the Postmaster General, for the nine months ended 31st March, 1907. Presented 3rd December, 1907, by Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

25. Report of the Department of the Interior, for the fiscal period from 1st July, 1906, to 31st March, 1907. Presented 29th November, 1907, by Hon. F. Oliver.
Printed for both distribution and sessional papers.

CONTENTS OF VOLUME 13.

25a. (1906) Report of the Chief Astronomer for the year ended 30th June, 1906. Presented 17th December, 1907, by Hon. F. Oliver...*Printed for both distribution and sessional papers.*

25a. (1907) Report of the Chief Astronomer for the nine months ending 31st March, 1907. *Printed for both distribution and sessional papers.*

25b. Annual Report of the Topographical Surveys Branch (Department of the Interior) 1906-7. Presented 8th June, 1908, by Hon. F. Oliver. *Printed for both distribution and sessional papers.*

25c. Report of the Commissioner of the Yukon Territory, for the year ended 31st March, 1908.... .. ..*Printed for both distribution and sessional papers.*

25d. Correspondence and papers relating to Seed Grain in Saskatchewan and Alberta. Presented 18th July, 1908, by Hon. F. Oliver. *Printed for both distribution and sessional papers.*

26. Summary Report of the Department of Mines (Geological Survey), for the calendar year 1907. Presented 16th January, 1908, by Hon. W. Templeman. *Printed for both distribution and sessional papers.*

26a. Summary Report of the Mines Branch of the Department of Mines, for the fiscal year 1907-8. Presented 17th July, 1908, by Hon. W. Templeman. *Printed for both distribution and sessional papers.*

26b. Annual Report on the Mineral Production in Canada, during the calendar year 1906. *Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 14.

27. Report of the Department of Indian Affairs, for the year ended 31st March, 1907. Presented 29th November, 1907, by Hon. F. Oliver. *Printed for both distribution and sessional papers.*

28. Report of the Royal Northwest Mounted Police, 1907. Presented 29th January, 1908, by Sir Wilfrid Laurier... .. ..*Printed for both distribution and sessional papers.*

29. Report of the Secretary of State of Canada, for the year 1907. *Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 15.

29a. Report of the Royal Commission on the Civil Service, with appendices and evidence taken before the Commissioners. Presented 26th March, 1908, by Hon. W. S. Fielding; also Analytical Index of evidence and memorials. *Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 16.

29a. Report of the Royal Commission on the Civil Service—*Continued.*

30. Civil Service List of Canada, 1907. Presented 3rd December, 1907, by Sir Wilfrid Laurier. *Printed for both distribution and sessional papers.*

CONTENTS OF VOLUME 17.

31. Report of the Board of Civil Service Examiners, for the year ended 31st December, 1907. Presented 8th May, 1908, by Hon. S. A. Fisher. *Printed for both distribution and sessional papers.*

32. Annual Report of the Department of Public Printing and Stationery, 1907. Pesented 11th May, 1908, by Hon. S. A. Fisher... ..*Printed for both distribution and sessional papers.*

33. Report of the Joint Librarians of Parliament for the year 1907. Presented 28th November, 1907, by the Hon. the Speaker... .. ..*Printed for sessional papers.*

CONTENTS OF VOLUME 17—*Continued.*

CONTENTS OF VOLUME 17—*Continued.*

CONTENTS OF VOLUME 17—*Continued.*

CONTENTS OF VOLUME 17—*Continued.*

CONTENTS OF VOLUME 17—*Continued.*

CONTENTS OF VOLUME 17—*Concluded.*

55*g*. Return to an order of the House of Commons, dated 18th February, 1907, for a copy of all letters, memorials, telegrams, petitions, resolutions and other communications, documents and papers from any person or persons in the Yukon to the Prime Minister or to the government, or any member or official of the government, respecting the official acts or conduct of Mr. W. W. B. McInnes as commissioner of the Yukon; including any petition asking for the removal of Mr. McInnes from his position as commissioner. Presented 7th April, 1908—*Mr. White*.. .. .. *Not printed.*

55*h*. Return to an order of the House of Commons, dated 13th January, 1908, for a copy of the report made by Mr. Beddoe upon the condition of the books, accounts, &c., of the financial administration of the Yukon, and especially with reference to the condition in the public administrator's office. Presented 21st April, 1908.—*Mr Foster.* *Not printed.*

55*i*. Return to an address of the House of Commons, dated 30th March, 1908, for a copy of all orders in council, reports, correspondence, documents, and papers relating to the appointment of Mr. W. H. P. Clement as legal adviser to the council of the Yukon Territory, or as public administrator in the Yukon Territory, or to any other office of emolument in the Yukon Territory, or relating to the resignation of the said W. H. P. Clement from any such office, or relating to the circumstances under which and reasons for which the said W. H. P. Clement ceased to act as such legal adviser, public administrator or in any other such capacity. Presented 7th May, 1908.—*Mr. Sproule.* *Not printed.*

56. Statement of expenditure as to bounty to deep-sea fishermen, for the year 1906-7. Presented 18th December, 1907, by Hon. L. P. Brodeur.. .. .. *Not printed.*

56*a*. Return to an order of the House of Commons, dated 13th January, 1908, showing the names and residences of all fishermen in the county of Cape Breton to whom fishing bounties were paid between 31st December, 1905, and 1st January, 1908, together with a statement of the amount paid to each person, the date on which it was paid, and the name of the officer or person by whom the sum was paid. Presented 11th February, 1908.—*Mr. Borden (Carleton)*.. .. .. *Not printed.*

56*b*. Supplementary return to No. 56*a*. Presented 13th July, 1908.. .. .. .. *Not printed.*

57. Correspondence and instructions with regard to the Lord's Day Act in its application to the Yukon Territory. Presented 18th December, 1907, by Hon. A. B. Aylesworth. *Not printed.*

CONTENTS OF VOLUME 18.

58. Minutes of Proceedings of the Colonial Conference held at the Colonial Office, Downing Street, London, from the 15th April to the 14th May, 1907. Presented 22nd May, 1908, by Sir Wilfrid Laurier.. .. .. .. *Printed for both distribution and sessional papers.*

59. Report of the Royal Commission on the Grain Trade of Canada. Presented 8th January, 1908, by Hon. F. Oliver.. .. .. .. *Printed for both distribution and sessional papers.*

60. Return to an order of the House of Commons, dated 18th December, 1907, for a copy of the report of the Honourable Justice James Henry Madden, appointed by order in council, 15th May, 1907, to investigate and report upon the matter of arrears for rentals on certain leases at Dunnville, Welland Canal feeder. Presented 9th January, 1908.—*Mr. Lalor*.. .. .. *Not printed.*

61. Return to an address of the House of Commons, dated 11th December, 1907, for a copy of all correspondence, petitions, statements, papers, orders in council, and proclamations respecting the setting out of limits for prohibition of the sale of liquors along the line of the Grand Trunk Pacific under the Public Works Construction Act. Presented 9th January, 1908.—*Mr. Foster*.. .. .. *Not printed.*

61*a*. Supplementary return to No. 61. Presented 27th January, 1908.. .. .. .. *Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

72. Supplementary return to an address of the House of Commons, dated 10th December, 1906, for a copy of all orders in council, correspondence, and all other papers, relating to the Standard Chemical Company (Limited), or Pevelan & Co., in its dealings with the Customs and Inland Revenue Departments from the date of the incorporation of the said company to the present date. Presented 16th January, 1908.—*Mr. Robitaille.* *Not printed.*

73. Return to an order of the House of Commons, dated 11th December, 1907 showing: 1. All promotions that have been made to the rank of colonel in the active militia during the past year, with names. 2. The nature of service, merit or seniority justifying such promotions. 3. The record of war services of such officers. 4. Previous to the gazetting of such promotion the positions held by such officers on the seniority list of the colonels. 5. The number of lieut.-colonels who were outranked or superseded by such promotions, with their names and services. Presented 17th January, 1908.—*Mr. Worthington*.. .. ..*Not printed.*

74. Return to an address of the House of Commons, dated 11th December, 1907, for a copy of all orders in council, correspondence, documents and papers relating to Chinese seeking admission to the public schools of British Columbia as students, and relating to the remission of head-tax on such persons Presented 20th January 1908.—*Mr. Borden (Carleton)*.. .. ..*Not printed.*

74*a*. Report of W. L. Mackenzie King, commissioner to inquire into the methods by which oriental labourers (Japanese) have been induced to come to Canada. Presented 20th January, 1908, by Hon. R. Lemieux.. .. ..*Not printed.*

74*b*. Return to an address of the House of Commons, dated 12th December, 1907, for a copy of all correspondence between the Government of Canada and the Imperial authorities, and a copy of all correspondence between the Government of Canada, and any person or persons, and of all reports communicated to the Government in respect to the Anglo-Japanese convention regarding Canada. Presented 21st January, 1908.—*Mr. Borden (Carleton)*.... .. ..*Printed for sessional papers.*

74*c*. Supplementary return to No. 74*b*. Presented 21st January. *Printed for sessional papers.*

74*d*. Supplementary return to an address of the House of Commons, dated 18th December, 1907, for a copy of all orders in council, correspondence, documents and papers, during the past ten years, relating to the immigration of Chinese and Japanese into Canada. Presented 24th February, 1908.—*Mr. Borden (Carleton)*.. .. ..*Not printed.*

74*e*. Return to an address of the House of Commons, dated 18th December, 1907, for a copy of all orders in council, correspondence, documents and papers, during the present year, relating to the immigration of Japanese into Canada. Presented 9th March, 1908.—*Mr. Borden (Carleton)*.... .. ..*Not printed.*

74*f*. Report of W. L. Mackenzie King, C.M.G., Deputy Minister of Labour, commissioner appointed to investigate into the losses sustained by the Chinese population of Vancouver, in the province of British Columbia, on the occasion of the riot in that city in September, 1907. Presented 30th June, 1908, by Hon. R. Lemieux. *Printed for both distribution and sessional papers.*

74*g*. Report by W. L. Mackenzie King, C.M.G., Deputy Minister of Labour, commissioner appointed to enquire into the losses and damages sustained by the Japanese population in the city of Vancouver, in the province of British Columbia, on the occasion of riots in that city in September, 1907. Presented 30th June, 1908, by Hon. R. Lemieux. *Printed for both distribution and sessional papers.*

74*h*. Report of W. L. Mackenzie King, C.M.G., commissioner appointed to enquire into methods by which Oriental labourers (Hindoo and Chinese) have been induced to come to Canada. Presented 13th July, 1908, by Hon. R. Lemieux.... .. ..*Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

of the respective parties with whom they are located, also the township in which such party resides; also the amount of money received by the said M. C. Dunne from the government for his services in salary, commission, or both; also the amount of moneys received by the said M. C. Dunne, respectively, from residents in the said county of Lennox and Addington for his services in securing the aforesaid immigrants. Presented 23rd January, 1908.—*Mr. Wilson (Lennox and Addington).. .. .. ..Not printed.*

81*b*. Return to an order of the House of Commons, dated 13th January, 1908, showing list of the names of immigration agents appointed by the government in each county of the province of Ontario, the county in which each such agent is employed, the number of immigrants placed by each such agent, and the amounts paid to each such agent for his services and expenses. Presented 30th January, 1908.—*Mr. Clements.Not printed.*

81*c*. Return to an order of the House of Commons, dated 11th December, 1907, for a copy of all reports received by the government from each of the special immigration agents sent to Great Britain and the continent of Europe, for the fiscal year ending 31st March, 1907. Presented 30th January, 1908.—*Mr. Wilson (Lennox and Addington). Not printed.*

81*d*. Return to an order of the House of Commons, dated 16th December, 1907, showing the number of immigrants who reached and settled in Canada during the fiscal years of 1905-6 and 1906-7, and from what countries they came. Presented 11th February, 1908. —*Mr. Paquet.. .. ..Not printed.*

81*e*. Return to an order of the House of Commons, dated 22nd January, 1908, for a copy of all correspondence between the Department of the Interior and James S. Waugh, immigration distribution agent, subsequent to 1st December, 1907. Presented 11th February, 1908.—*Mr. Gordon.. .. ..Not printed.*

81*f*. Return to an order of the House of Commons, dated 3rd February, 1908, showing what special immigration agents the Government of Canada has in the British Islands; their respective names, and from what parts of Canada they come; the arrangements made by the Government with the said agent or agents as to salary and expenses; the date of their respective appointments, and at what time they left this country to take up their work. Presented 11th February, 1908.—*Mr. Wilson (Lennox and Addington). Not printed.*

81*g*. Return to an Address of the House of Commons, dated 29th January, 1908, for a copy of all orders in council now in force with respect to immigration from every country from which immigrants come to Canada; also a copy of all circulars in force at the present time with reference to immigration. Presented 13th February, 1908.—*Mr. Wilson (Lennox and Addington).. .. ..Not printed.*

81*h*. Return to an order of the House of Commons, dated 20th January, 1908, for a copy of all certificates by farmers resident in the riding of West Kent, and returned to the department by emigration agents for the said riding, and on certificates such agents were paid for placing emigrants with each farmer, giving the names of each emigrant and of each farmer such were placed with, giving the total amount received by each agent up to the present time Presented 3rd March, 1908.—*Mr. Clements...Not printed.*

81*i*. Return to an order of the House of Commons, dated 11th March, 1908, for a copy of all certificates by A. G. McDonald, immigration agent for Prince Edward County, Ontario, claiming payment for immigrants by him alleged to have been placed with farmers or other employers; also, a copy of all certificates or communications by such farmers or other employers received by the Department of the Interior relating to immigrants so claimed as placed by said A. G. McDonald, giving in each case the name and post office address of the immigrant and of the farmer or the employer. Presented 13th April, 1908.—*Mr. Alcorn.. .. ..Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

successful tenderer; (*i*) amount of bonus paid; (*j*) date when definite selection of blocks was completed and the returns of the survey filed with the Department of the Interior at Ottawa; (*k*) amount of dues collected during the year ending the 30th of April, 1907. in respect of each berth for ground rent, stumpage royalty, and the cost of fire guarding, &c.; also the amount, if any, unpaid and overdue at the termination of said year; (*l*) whether license was issued according to order in council of April 14th, 1903, or of July 23rd, 1906; (*m*) in case of berths upon which during the year 1906-7 no timber was cut, whether notification has been served on license holder to operate a saw-mill, and the date of such notice. Presented 11th March, 1908.—*Mr. McCarthy (Calgary)* *Not printed.*

88*j*. Return to an order of the House of Commons, dated 11th December, 1907, bringing the information as contained in Sessional Paper No. 167*b*, brought down April 26th, 1907, up to date. Presented 13th March, 1908.—*Mr. Ames*.. .. ..*Not printed.*

88*k*. Return to an order of the House of Commons, dated 3rd February, 1908, for a copy of all letters, correspondence, applications, advertisements, reports, memoranda, valuations, estimates, tenders, transfers, or other writings or papers in respect of or in connection with timber berths numbers 1413, 1414 and 1415. Presented 16th March, 1908.—*Mr. Lennox*.. .. ..*Not printed.*

88*l*. Return to an order of the House of Commons, dated 26th February, 1908, for a copy of all applications to homestead or purchase, reports, agreements of lease or sale, correspondence exchanged between the Department of the Interior and any person whatsoever, and papers of every description dealing with or treating of the sale or lease of surface, mining, timber, or any other rights in respect of the n.w. ¼ of section 8, township 53, range 4, west of the 5th M. Presented 19th March, 1908.—*Mr. Ames.* *Not printed.*

88*m*. Return to an order of the House of Commons, dated 18th December, 1907, showing, in respect of timber berths numbers 1220 to 1226, 1238 and 1272, all bonuses, rentals or dues paid to date by the lessees or other assigns to the Government, together with a copy of all applications, correspondence, reports, advertisements, tenders, leases, transfers or memoranda of any description in connection therewith. Presented 24th March, 1908.—*Mr. Lake*.. .. ..*Not printed.*

88*n*. Return to an order of the House of Commons, dated 9th March, 1908, for a copy of applications, recommendations of applications, and replies thereto, instructions, regarding advertising, and a copy of all tenders and replies thereo, for timber berths numbers 652, 657, 677, 679, 681, 683, 684, 721, 722, 730 and 743. Presented 30th March, 1908.—*Mr. McCraney*.. .. ..*Not printed.*

88*o*. Return to an order of the House of Commons, dated 2nd March, 1908, for the production of all the original applications and tenders filed in the Department of the Interior in respect of timber berths 1046, 1047, 1052, 1058, 1068, 1070, 1093, 1094, 1099, 1191, 1192 and that the same be laid upon the Table of the House, said papers not to be part of the archives of this House, but to be returned by the Clerk to the Department of the Interior after inspection. Presented 13th April, 1908.—*Mr. Ames*.. .. .. ..*Not printed.*

88*p*. Return to an Address of the House of Commons, dated 26th February, 1908, for a copy of all orders in council, letters, telegrams, reports, recommendations, tenders or communications of any kind in relation to the granting of sixteen townships and certain timber limits in the Peace River region, as referred to in a motion of the 15th January, ult., reference 102, not already brought down. Presented 13th April, 1908.—*Mr. Hughes (Victoria and Haliburton)*.. .. ..*Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

96. Return to an address of the House of Commons, dated 17th December, 1906, for a copy of all orders in council, advertisements for tenders, tenders, specifications of every kind, plans, drawings, reports, letters, telegrams, correspondence, contracts, agreements and other documents and papers of every kind, touching or relating to any works at or near St. Andrews Rapids, in the province of Manitoba, and especially such documents as aforesaid in connection with any tender or contract by or on behalf of Charles Whitehead, or Kelly Brothers, or any subsequent tenderers or contractors. Presented 29th January, 1908.—*Mr. Borden (Carleton)*.. .. ..*Not printed.*

97. Return to an order of the House of Commons, dated 13th January, 1908, for a copy of all papers, correspondence, and evidence, in respect of the trial for criminal conspiracy against certain persons in the Yukon in connection with the Dominion elections of 1904. Presented 3rd February, 1908.—*Mr. Foster* .. ..*Not printed.*

98. Return to an order of the House of Commons, dated 13th January, 1908, for a copy of all correspondence between Major E. S. Wigle, of Windsor, Honourable R. F. Sutherland, A. H. Clarke, and the Minister of Inland Revenue, respecting the extension of the franchise of the Windsor, Detroit and Belle Isle Ferry Company. Presented 3rd February, 1908.—*Mr. Clements*.. .. ..*Not printed.*

99. Return to an order of the House of Commons, dated 29th January, 1908, for a copy of all correspondence, telegrams, or reports, respecting the refusal of the lieutenant governor of British Columbia to give his assent to a bill passed by the legislature of that province in 1907, respecting immigration and commonly referred to as the Natal Act. Presented 3rd February, 1908.—*Mr. Smith (Nanaimo)*.. .. ..*Printed for sessional papers.*

100. Return to an address of the House of Commons, dated 11th December, 1907, for a copy of all papers and correspondence between the government of Canada and any of its ministers with reference to the establishment of a fast line of steamship communication between Great Britain, Australia, New Zealand and Canadian ports. Presented 3rd February, 1908.—*Mr. Foster*.. .. ..*Not printed.*

101. Return to an order of the House of Commons, dated 11th December, 1907, for a copy of all correspondence, enclosed clippings, agreements, statements, &c., between the government or any member thereof, and especially the Minister of Marine and Fisheries, the Minister of Railways, the Minister of Agriculture, the Minister of Militia, and Sir Wilfrid Laurier, and one F. E. Williams, of St. John, New Brunswick; one W. H. Trueman, of St. John, and any other person or persons whatsoever in relation to the establishment of a bait freezer and cold storage established in St. John, New Brunswick. Presented 5th February, 1908.—*Mr. Foster*.. .. ..*Not printed.*

102. Return to an order of the House of Commons, dated 11th December, 1907, showing the expenditure by the Dominion Government on (*a*)wharfs; (*b*) harbours and river improvements; (*c*) dredging; (*d*) public buildings; for each year since 1896, in the counties of Digby, Yarmouth, Shelburne, Queen's, Lunenburg and Pictou, Nova Scotia, specifying the works by name, with amounts expended thereon. Presented 6th February, 1908.—*Mr. Foster*.. .. ..*Not printed.*

103. Return to an order of the House of Commons, dated 20th January, 1908, for a copy of letters, telegrams, and reports, regarding complaints made by John Franklin and Stapleton Brothers, with respect to Indian Agent Yeomans. Presented 6th February, 1908.—*Mr. Foster*.. .. ..*Not printed.*

104. Return to an order of the House of Commons, dated 20th January, 1908, showing the amount paid each year for provisions for the Royal Military College, for the Halifax Garrison, and the Permanent Military School in Quebec, the average number of men provisioned each year of the above institutions, and cost per man per day. Presented 10th February, 1908.—*Mr. Foster*.. .. ..*Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

124*a*. Return to an order of the House of Commons, dated 18th December, 1907, showing what sums have been voted or expended for the dredging of the river bottom between Charlemagne and Terrebonne; since when the dredging has been going on there; what sums have been voted or expended for wharfs at Terrebonne and at St. François de Sales; and who obtained the contracts. Presented 24th February, 1908.—*Mr. Bergeron.* *Not printed.*

124*b*. Return to an order of the House of Commons, dated 11th December, 1907, showing: 1. What harbours or rivers in the province of Ontario were tenders invited for dredging work by the Department of Public Works during the present year. 2. The names of the successful tenderers at each of the said places for which dredging tenders were invited in Ontario in 1907, and the prices asked by each party respectively. 3. Amounts of the tenders respectively of the different persons tendering at each of the foregoing points. 4. Also at what points new tenders were invited, and when the first tenders wero accepted. Presented 9th June, 1908.—*Mr. Bennett*.. .. ..*Not printed.*

124*c*. Return to an order of the House of Commons, dated 6th of April, 1908, for a copy of all the correspondence exchanged between the Government and Messrs. T. B. Mongenais, Hugh McMillan and others, relating to dredging work done in the River Rigaud, formerly the River Graisse, up to the year 1890. A copy of the reports and correspondence relating to the construction or purchase of the Graham wharf. A copy of the report and correspondence relating to the dredging done at Como up to 1900. A copy of the reports and correspondence relating to the dredging done at Vaudreuil Village, and also those relating to the construction and repair of the wharf situated in that village since 1867. And also a copy of the report and correspondence relating to the deepening of the River St. Louis at Beauharnois. Presented 30th June, 1908.—*Mr. Boyer*.. .. ..*Not printed.*

125. Return to an order of the House of Commons, dated 3rd February, 1908, for a copy of all correspondence, telegrams, engineer's reports, &c., in the hands of the Government or any member or official thereof, respecting proposed repairs to the wharf at Little Sands, in Prince Edward Island. Presented 25th February, 1908.—*Mr. Martin (Queen's).* *Not printed.*

126. Return to an order of the House of Commons, dated 12th February, 1908, for a copy of the report made by John Fraser, of the Auditor General's Department, on the 7th January, 1898, of a special examination held by him of the financial affairs of the Montreal Turnpike Trust. Presented 10th March, 1908.—*Mr. Monk*.. .. ..*Not printed.*

126*a*. Return to an order of the House of Commons, dated 22nd January, 1908, showing: 1. The present indebtedness to the Dominion Government of the Montreal Turnpike Trust (*a*) on capital account, (*b*) for arrears of interest. 2. The amounts collected at each toll gate belonging to the said Turnpike Trust during the three years ending 31st December, 1905, 1906, 1907, respectively. 3. The names of all parties who have commuted their tolls during each of the above-mentioned years, 1905, 1906, 1907, and the amount of the commutation money paid to the Trust in each case. 4. The amounts expended on each section or road division, under the control of the said Trust, during each of the said years, ending 31st December, 1905, 1906, and 1907, respectively, and the contracts given out during each of the said years, with the name of the contractor and the date and amount involved in each case; and a statement in each case also as to whether the contract was awarded after tender called through the newspapers. 5. The amount paid out during each of the said three years, 1905, 1906, 1907, at each toll gate for salaries of day and night guardians, and any other expenditure at each of the toll gates maintained. 6. The names of all parties holding passes for free use of the roads under control of said Trust, during each of the said three years above referred to, 1905, 1906, 1907, with a statement in each case of the reason why the pass was so granted. 7. The expense of the said Trust during each of the said years, for rent, salaries of the

CONTENTS OF VOLUME 18—*Continued.*

office, inside or outside service, giving name and remuneration of each official. 8. The actual present indebtedness in detail of the said Trust outside of its bonds due to the Government of Canada. 9. The amounts collected, by said Trust, year by year, since the 1st February, 1905, from municipalities under special agreements made as to their share pro rata of the bonded indebtedness of the Turnpike Trust. 10. The names of all those members of the Trust appointed or elected to represent the bondholders since the 1st July, 1896, with the date of the election in each case. 11. The amounts paid by the Trust to any of its members or officials during each of the said three years, 1905, 1906, 1907, whether as travelling or personal expenses, or indemnity for attendance or for any other reason whatever. 12. The name of the auditor of the Trust, and the date of the audit made of the company's affairs, in each of the said three years, 1905, 1906, 1907, respectively. 13. A copy of the agreements between the Trust and any municipalities on the Island of Montreal, by which the Trust ceded to said municipalities any portion of its roads, said copy to be certified by the president and secretary of said Trust. Presented 20th March, 1908.—*Mr. Monk*.. .. ..*Not printed.*

127. Return to an address of the Senate, dated 24th January, 1908, for a copy of the different tariffs in force upon the Intercolonial Railway, in 1896-7 and 1906-7, between Quebec and St. Flavie, and all intermediate stations between those two points, for the carriage of passengers or of goods, under the operation of the winter-tariff and under that of the summer-tariff. Presented 24th February, 1908.—*Hon. Mr. Landry*.. ..*Not printed.*

128. Statement of the affairs of the British Canadian Loan and Investment Company, Limited, for the year ended the 31st of December, 1907. Presented 25th February, 1908, by the Hon. The Speaker.. .. ..*Not printed.*

129. Return to an order of the House of Commons, dated 19th February, 1908, showing how much money has been paid since 1896 to the Eclipse Manufacturing Company of Ottawa; how much each year; and the general character of the supplies furnished. Presented 27th February, 1908.—*Mr. Blain*.. .. ..*Not printed.*

130. Return to an order of the House of Commons, dated 10th February, 1908, for a copy of all correspondence between Mr. A. E. Dyment, M.P., and the Department of Marine and Fisheries as to granting of pound net licenses in 1905 to Messrs. Low & Roque, of Killarney, as also to any other persons; also a list of persons to whom pound net licenses were granted in that year. Presented 27th February, 1908.—*Mr. Bennett.* *Not printed.*

131. Return to an order of the House of Commons, dated 12th December, 1907, showing: 1. The number of disputes dealt with under the Industrial Disputes Investigation Act, 1907, to the 1st of December, 1907. 2. The dates at which the several applications for the operation of the Act have been received. 3. Names of the parties concerned in the several disputes. 4. Name of the party making application. 5. Locality of dispute. 6. Number of persons affected. 7. Nature of dispute. 8. Names of members of board of conciliation and investigation where same has been established. 9. Date on which board was established. 10. Date of sittings of board. 11. Result of the reference of the dispute under Act. Presented 27th February, 1908.—*Mr. Smith (Nanaimo).* *Not printed.*

132. Return to an order of the House of Commons, dated 12th February, 1908, for a copy of correspondence, plans, and other data in connection with the flooding of roads above the dam at Wilberforce, in Haliburton County, and the proposals, if any, for improving said roads and the bridge so as to prevent obstruction of traffic. Presented 27th February, 1908.—*Mr. Hughes (Victoria and Haliburton)*..... .. ..*Not printed.*

133. Return to an order of the House of Commons, dated 17th February, 1908, for a copy of reports, plans, surveys, and other data, in connection with the proposal to construct a branch canal from Balsam Lake, on the Trent Canal, to the head of Gull River waters, in Haliburton County. Presented 27th February, 1908.—*Mr. Hughes (Victoria and Haliburton)*... .. ..*Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

CONTENTS OF VOLUME 18—*Continued.*

141*a*. Return to an order of the House of Commons, dated 13th January, 1908, showing what contracts for dredging in the St. Mary's river, Kaministiquia river, Mission river, Port Arthur harbour, Fort William harbour, and in Thunder Bay, or of any of the inlets or rivers thereof, have been let during the years 1904, 1905, 1906 and 1907, showing also: (*a*) the names, addresses and calling of all the tenderers in each case; (*b*) the amount of each tender; (*c*) the nature and extent of the work to be let in each case; (*d*) the names, addresses and calling of the successful tenderer in each case; (*e*) the prices at which each contract was let, (*f*) the nature or form of security for the due performance of the work in each case, and (*g*) the disposition of or change in the form of any such security after it was originally given or deposited; also, for a copy of all tenders, contracts, bonds or other securities, and of all correspondence relating or incident to all or any such tenders or contracts, including all correspondence relating to such contracts, or incident thereto, before and during the performance of the work and on file up to the date of the order for such return. Presented 17th July, 1908.—*Mr. Boyce.* *Not printed.*

142. Return to an address of the House of Commons, dated 18th December, 1907, for a copy of all orders in council, correspondence, contracts, papers and reports in connection with the employment of certain experts to prepare a system of accounting and book-keeping in the Department of Marine and Fisheries. Presented 2nd March, 1908.—*Mr. Foster.* *Not printed.*

143. Return to an order of the House of Commons, dated, 11th December 1907, for a copy of all correspondence in connection with the application, granting, operation or renewal of license and lease conveying the privileges of fishing in Cedar, Moose, Cormorant and Clearwater Lakes; also a copy of said license and lease. Presented 3rd March, 1908.—*Mr. Ames*... .. ..*Not printed.*

144. Certain papers referring to Treaty Powers, &c. Presented 3rd March, by Hon. L. P. Brodeur.. .. ..*Printed for sessional papers.*

145. Return to an order of the House of Commons dated 11th March, 1907, for a copy of all papers, affidavits and correspondence between the Government, or any official thereof, with the Prince Edward Island Railway, or any official thereof, or any other persons in reference to the leasing of the properties of Widow James Wiggins and Charles Malley, at Alberton, Prince Edward Island. Presented 3rd March, 1908.—*Mr. Lefurgey.* *Not printed.*

146. Return to an order of the House of Commons, dated 11th December, 1907, showing the total amount of money paid yearly from the year 1892 to 1st December, 1907, on each of the following accounts: (*a*) Salary of Governor General; (*b*) Travelling expenses of Governor General; (*c*) Expenditure on Rideau Hall, capital account; Expenditure on Rideau Hall, maintenance; Expenditure on Rideau Hall grounds, capital account; Expenditure on Rideau Hall grounds, maintenance; (*d*) Expenditure on furnishings of all kinds for Rideau Hall; (*e*) Expenditure on any other account in connection with the office of Governor General; (*f*) Expenditure on any other account in connection with Rideau Hall and grounds; (*g*) Total expenditure of every kind yearly since 1892 in connection with the office of Governor General; (*h*) Total expenditure of every kind yearly in connection with Rideau Hall grounds. Presented 5th March, 1908.—*Mr. Wilson (Lennox and Addington)*.. .. ..*Not printed.*

147. Return to an address of the House of Commons, dated 15th January, 1908, for a copy of all correspondence, telegrams, orders in council, contracts and tenders, with the names, and amounts of each, in possession of the Government, or any member or official thereof, respecting the construction of a breakwater at Petit Rocher, on the south-western side of Baie des Chaleurs, as detailed on page 74 of the Report of the Minister of Public Works for the year ended 31st March, 1907. Presented 5th March, 1908.—*Mr. Taylor*... .. ..*Not printed.*

147*a*. Supplementary Return to 147. Presented 12th June, 1908.. .. ..*Not printed.*

CONTENTS OF VOLUME 18—*Continued.*

148. Return to an order of the House of Commons, dated 17th February, 1908, showing the individual name and place of residence of the captain and crew of each of the Government steamers *Lansdowne, Aberdeen, Druid, Brant, Lady Laurier, Minto* and *Stanley.* Presented 5th March, 1908.—*Mr. Stanfield*.. .. ..*Not printed.*

148a. Return to an order of the Senate, dated the 5th of February, 1908, for a statement showing, in so many columns: 1. The names of the officers actually employed on board of Government vessels or of vessels hired by the Government for the season of navigation in the River St. Lawrence. 2. The amount of wages or salaries paid monthly to each of them for the period of their annual engagement. 3. The amount of wages or salaries paid monthly to those who are only employed for a part of the year. 4. The amount of wages or salaries paid monthly to those who, over and above their real service, are paid a part of their wages or salaries during the months in which the vessels are laid up for the winter. Presented 20th February, 1908.—*Hon. Mr. Landry.* *Not printed.*

149. Return showing what changes have occurred in the House of Commons branches of the Clerk of the House and the Sergeant-at-arms' service since 1st July, 1907. Presented 5th March, 1908.—*Mr. Owen*.... .. ..*Not printed.*

150. Return to an order of the House of Commons, dated 10th February, 1908, showing: 1. How many Returns or Sessional Papers have been presented to Parliament in answer to motions for the same, since the 1st of January, 1906. 2. How many of these Returns were taken out of the Office of Routine and Records, and the Journal Office, by members of this House, since the above date, giving also the name of the member to whom delivered. 3. For what length of time such Returns were retained by the members who obtained them. 4. How many of these Returns had not been returned to the proper officer of the House of Commons on the 1st of January, 1908. 5. In the case of those returned, how long they were out with the members. 6. How many of these Returns are still in the possession of the members, and how long they have had them. 7. The means usually adopted by the Clerk of Routine and Records and the Clerk of Current Sessional Papers to have outstanding returns retransferred to their possession. 8. The average cost to the country of preparing these Returns by the various departments interested, during the above period. Presented 6th March, 1908.—*Mr. Johnston.* *Not printed.*

151. Return to an order of the House of Commons, dated 16th December, 1907, showing: 1. The number of fishing licenses, the names of the parties to whom issued, and also the amounts of the revenues received from each license, on any or all of the lakes in the province of Saskatchewan. 2. For a copy of all correspondence in connection with each license so issued and in force, or about to be issued. 3. Also for a copy of the different forms used for fishing licenses in the province of Saskatchewan. Presented 9th March, 1908.—*Mr. Chisholm (East Huron)*.. .. ..*Not printed.*

152. Return to an order of the House of Commons, dated 20th January, 1908, for a copy of all correspondence, documents and papers, in the investigation into the case of Mr. O. S. Finnie, chief clerk in the gold commissioner's office, Dawson, Y.T. Presented 6th March, 1908.—*Mr. Thompson*.. .. ..*Not printed.*

153. Return to an order of the House of Commons, dated 19th February, 1908, for a copy of all correspondence between Lieut.-Colonel Mallette, of the 64th Battalion, and the Department of Militia and Defence, concerning Major Sabourin, of St. John, Quebec. Presented 6th March, 1908.—*Mr. Bergeron*.. .. ..*Not printed.*

153a. Return to an order of the House of Commons, dated 19th February, 1908, for a copy of all correspondence between Lieut.-Colonel Mallette, of the 64th Battalion, and the Department of Militia and Defence, for the organization of a regiment in Valleyfield, Quebec. Presented 6th March, 1908.—*Mr. Bergeron*.. .. ..*Not printed*

CONTENTS OF VOLUME 18—*Concluded.*

154. Report of the Royal Commission on the Quebec Bridge inquiry; also the Report on the Design of the Quebec Bridge by C. C. Schneider; with Appendices. Presented 9th March, 1908, by Hon. G. P. Graham.

Printed for both distribution and sessional papers

CONTENTS OF VOLUME 19.

154. (Vol. 2.) Royal Commission Quebec Bridge inquiry. Minutes of proceedings. Evidence and exhibits.. .. ..*Printed for both distribution and sessional papers.*

154*a*. Return to an address of the House of Commons, dated 12th December, 1907, for a copy of all orders in council, correspondence, reports, memoranda, papers and documents, since the 1st day of January, 1900, relating to the Quebec Bridge, including all reports and orders in council, relating to the plans and specifications for the works of the undertaking, or to any approval thereof by the Governor in Council, or by the Department of Railways and Canals. Presented 26th May, 1908.—*Mr. Borden (Carleton).*

See No. 154.

154*b*. Return to an address of the Senate, dated 29th Januray, 1908, for a statement showing: 1. If the Quebec Bridge and Railway Company has fulfilled the obligation which was imposed upon it by clause 4 of the agreement made, between it and the Government, on the 19th day of October, 1908, which clause reads as follows: "4. The company will procure subscriptions for additional stock to the amount of $200,000, such new stock to be issued at a price not below par and to be immediately paid up in full, the proceeds to be applied in the first place to the payment of the discount at which the bonds of the company were issued as aforesaid, to wit the sum of $188,721." (Being exactly the difference between the sum of $472,000, the amount of bonds issued, and the sum of $283,279, for which these same bonds were accepted.) 2. When did the company so furnish subscriptions for additional work to the amount of $200,000. 3. Who are the persons or the companies who divided among them this additional stock to the round sum of $200,000. 4. On what date and for what amount did each of these persons or each of these companies become owner of the aforesaid stock. 5. On what date did each of the aforesaid persons or companies pay into the hands of the company the price (in part or in whole) of the stock so subscribed. 6. And if this amount of $200,000 was paid in full and in what manner, distinguishing the amount paid in cash from the amount paid in promissory notes or in any other ways. Presented 2nd June, 1908.—*Hon. Mr. Landry*.. .. ..*See No. 154.*

154*c*. Return to an address of the Senate, dated the 29th January, 1908, showing: 1. The amount of money really paid by each of the present directors of the Quebec Bridge and Railway Company into the capital stock of the said company. 2. The date each of these directors made each of his payments. 3. Among these payments or instalments the proportion or amount that has been paid by means of promissory notes or of unaccepted cheques. 4. By whom individually, and for what amount each one. 5. The amount of money each of its directors has received from the Quebec Bridge Company and from the Quebec Bridge and Railway Company up to this date, directly or indirectly, personally or otherwise. 6. The nature of the services rendered for which each of these amounts was paid. 7. The amount the present secretary has received out of the funds of the company since he has been in the service thereof. 8. The resolution that subsequently to the collapse of the Quebec Bridge, within a few days immediately following the disaster, the bridge company has voted giving a bonus of $3,000 to its president. 9. The name of the funds, out of which the amount of this bonus was raised. 10. The resolution, if any, the company, on the same occasions, voted to aid the families of the victims of that disaster. Presented 18th February, 1908.—*Hon. Mr. Landry.*

Not printed.

155. Return to an order of the House of Commons, dated 10th February, 1908, showing what land has been withdrawn for settlement, or set apart, or sold, for colonization pur-

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

163. Return to an order of the House of Commons, dated 12th February, 1908, showing: 1. The total revenue of Belleville, Ontario, Harbour, for the years 1903, 1904, 1905, 1906 and 1907. 2. The expenditure for the years above-mentioned in the harbour; (*a*) for salaries, and to whom, (*b*) dredging in each year; (*e*) for building retaining walls along the river at entrance of harbour; and (*d*) to whom or what persons such last-named sums were paid. 3. What money, if any, the Government has advanced to the Harbour Commissioners of Belleville for improvements, how much and when. 4. If any money has been advanced, what security the Government holds for repayment of the same. 5. The tenders received for building the retaining walls for improvement of Belleville Harbour, the tenderers, the amount of each tender, and to whom the contract was awarded. Presented 13th March, 1908.—*Mr. Porter*.. .. ..*Not printed.*

164. Copy of the order in council appointing Mr. Richard L. Drury, of Victoria, B.C., as a special officer of the Immigration Branch of the Department of the Interior in Japan. Presented 17th March, 1908, by Sir Wilfrid Laurier.. .. ..*Not printed.*

165. Return to an order of the House of Commons, dated 19th February, 1908, for a copy of all letters, telegrams, reports, documents and papers (so far as the same are not of a confidential character) in relation to the trial and conviction of one Frederick Blunden, for cattle stealing at Macleod, in the province of Alberta, in 1904. Presented 19th March, 1908.—*Mr. Ward*.. .. ..*Not printed.*

166. Return to an order of the Senate, dated the 17th March, 1908, for a copy of the Minutes of the meeting of the Standing Committee of the Senate on Railways, Telegraphs and Harbours, held on the 21st and 22nd of May, 1901, be laid on the table. Presented 18th March, 1908.—*Hon. Mr. Landry*.. .. ..*Not printed.*

167. Return to an order of the House of Commons, dated 23rd March, 1908, for a copy of the interim report of the commissioner appointed to investigate alleged irregularities at Sorel in connection with construction of piers on Lake St. Peter. Presented 23rd March, 1908.—*Hon. L. P. Brodeur*.. .. ..*Not printed.*

168. Return to an order of the House of Commons, dated 20th January, 1908, showing all fines imposed for violation of the Fisheries Act in Division No. 2, Nova Scotia, comprising the counties of Antigonish, Colchester, Cumberland, Guysborough, Halifax, Hants and Pictou, showing the amount of each fine, dates on which same were imposed and paid, the place of trial in each case, the offence charged, and the names of the convicting justices or fishery officers. Presented 23rd March, 1908.—*Mr. Sinclair.* *Not printed.*

169. Return to an address of the House of Commons, dated 11th March, 1908, for a copy of all orders in council, reports, correspondence, documents, letters and papers not already brought down, relating to a grant by His Majesty of any Indian reserves in the province of British Columbia to the Grand Trunk Pacific Railway Company, or to any officer of the company, or to any person on behalf of that company. Presented 24th March, 1908.—*Mr. Borden (Carleton)*.. .. ..*Printed for sessional papers*

170. Return to an order of the House of Commons, dated 20th January, 1908, showing the amount paid each year for provisions on each of the Government steamers for the last three fiscal years, the average complement of officers and men provisioned on each for each year, and the cost per man per day. Presented 24th March, 1908.—*Mr. Foster.* *Not printed.*

171. Return to an order of the House of Commons, dated 12th February, 1908, for a copy of all petitions and correspondence relating to the establishment of a post office at Mill Settlement, West, and also at north side of Newcastle Creek, in the electoral division of Sunbury and Queen's. Presented 26th March, 1908.—*Mr. Wilmot*.. .. ..*Not printed.*

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

172. Return to an order of the House of Commons, dated 26th February, 1908, showing what sums of money were paid during the fiscal years 1905-6 and 1906-7 by any department of the Government to the Steel Concrete Company, Limited; for what purpose such payments were made; what orders for work or material to be done or supplied by that company are now being filled, and the aggregate amount payable for same. Presented 26th March, 1908.—*Mr. Boyce*.. .. ..*Not printed.*

173. Return to an order of the House of Commons, dated 9th March, 1908, showing how many renewals of placer claims were granted by the Gold Commissioner at Dawson, on or subsequent to the 1st of August, 1906, at $10 each; why the fee of $15, as required by 6 Edward VII., chapter 39, was not collected in these cases; and what shortages were afterwards collected. Presented 27th March, 1908.—*Mr. Lennox*.. .. .. ..*Not printed.*

173*a*. Return to an order of the House of Commons, dated 9th March, 1908, showing how many renewals of placer claims were granted by the Assistant Gold Commissioner at Whitehorse on or subsequent to 1st of August, at $10 each; why the fee of $15, as required by 6 Edward VII., chapter 39, was not collected in these cases; and what shortages have been collected. Presented 30th March, 1908.—*Mr. Lennox*..*Not printed.*

174. Return to an order of the House of Commons, dated 8th January, 1908, showing: 1. What sums of money have been paid for advertising and printing, respectively, to the *Sun* and *Star* newspapers of St. John, N.B., the *Chronicle* of Halifax, the *Echo* and the Glace Bay *Gazette*, and the St. John *Globe*, during the following periods respectively: the fiscal years 1904-5, 1905-6, and from June 30, 1906, to date. 2. In what offices or job offices the printing is done for the *Sun, Star, Chronicle* and *Echo.* Presented 30th March, 1908.—*Mr. Foster*... .. ..*Not printed.*

174*a*. Return to an order of the House of Commons, dated 13th June, 1908, showing all sums of money paid by the Government, or any department or official thereof, during the years 1902, 1903, 1904, 1905, 1906 and 1907, for advertising, printing, or for any other purpose, or on any other account whatever, to the *Sault Express*, a newspaper published at Sault Ste. Marie, Ontario, or to any person or persons, firm or company for or in respect of any work done by said newspaper for the Government, or any department or official thereof; also showing what amounts, if any, are disputed and unpaid, and showing for what purpose such moneys were paid, and accounts were incurred, respectively, and by what departments, or officials of the Government. Presented 30th March, 1908.—*Mr. Boyce*.. .. ..*Not printed.*

174*b*. Return to an order of the House of Commons, dated 22nd January, 1908, showing what amount has been paid by the Dominion Government for all purposes, from 1st January, 1904, to 1st January, 1908, to the following papers: *Alberta Star*, Cardston; *Lethbridge Herald, Macleod Advance, Nanton News, The Frank Paper.* Presented 30th March, 1908.—*Mr. Herron*.. .. ..*Not printed.*

175. Return to an order of the House of Commons, dated 15th January, 1908, showing the various services on which Mr. Shepley, K.C., has been engaged by the Government since 1896, and the amount that has been paid him for salary and expenses for each. Presented 30th March, 1908.—*Mr. Foster*.... .. ..*Not printed.*

176. Return to an address of the House of Commons, dated 16th March, 1908, for a copy of all orders in council, letters, telegrams, correspondence and papers of every description and nature relating to the appointment of the Hon. Arthur Drysdale as justice of the Supreme Court of Nova Scotia, and especially all such documents as relate to the date of his acceptance of said appointment or the date of his declaration of intention to accept the same. President 30th March, 1908.—*Mr. Taylor*.. .. ..*Not printed.*

177. Return to an order of the House of Commons, dated 23rd March, 1908, showing how much has been paid to C. Boone or the Boone Company, since 1896, and the amount paid for work in each year at each point where same was performed by said party, firm or company. Presented 30th March, 1908.—*Mr. Bennett*.. .. ..*Not printed.*

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

Civil Service Commission, reflecting on the integrity of the officials of the Department of Marine and Fisheries. Presented 1st May, 1908, by Hon. A. B. Aylesworth. *Not printed.*

182*d*. Return to an order of the House of Commons, dated 15th January, 1908, showing all commissions of inquiry appointed between 1896 and 1908, the dates of appointment thereof, the names of the commissioners appointed and the secretary and counsel, or others appointed to assist them, the purpose or object of each such commission, the date of report of each such commission, what legislation, if any, has been enacted in consequence of such commissions and reports, the cost of each such commission, including salaries, travelling expenses, witness fees, fees of counsel, and other assistants, and for printing, distinguishing each separately. Presented 5th May, 1908.—*Mr. Porter.* *Not printed.*

183. Return to an order of the House of Commons, dated 18th December, 1907, showing the various Marconi stations established by the Government, their location, the cost of construction and maintenance of each, the messages sent by each, the rate of tolls and the receipts, and all contracts, reports, papers and correspondence, in connection therewith. Presented 3rd April, 1908.—*Mr. Foster*.. .. ..*Not printed*

183*a*. Supplementary Return to No. 183. Presented 11th May, 1908.. .. ..*Not printed.*

184. Return to an order of the House of Commons, dated 17th February, 1908, showing what quality or quantity of goods or supplies have been furnished by the Office Specialty Company to the Dominion of Canada in every department of the service since 1896, and the total amount for each year. Presented 3rd April, 1908.—*Mr. Bennett*..*Not printed.*

185. Return to an address of the House of Commons, dated 19th February, 1908, for a copy of a memorial addressed to His Excellency the Governor General, respecting a reference to the Privy Council in regard to the constitutionality of the Saskatchewan Act passed by the Legislative Assembly of the province of Saskatchewan on the 23rd May, 1906; together with a copy of all correspondence, telegrams or other communications, relating thereto, between the Dominion Government or any member thereof, and the Government of Saskatchewan or any member thereof. Presented 31st March, 1908.—*Mr. Lake*.. .. ..*Printed for sessional papers.*

186. Return to an order of the House of Commons, dated 29th January, 1908, for a copy of all reports, plans, specifications, tenders, correspondence, telegrams, and all other papers, documents, and other information in connection with the construction of the Hillsboro' Bridge and approaches, including land purchases necessary therefor. Presented 6th April, 1908.—*Mr. Lefurgey*.. .. ..*Not printed.*

187. Return to an order of the House of Commons, dated 10th February, 1908, showing what action, if any, has been taken by this Government since 19th March, 1903, which would have for its object the removal of the cattle embargo upon Canadian cattle entering Great Britain. 2. For a copy of a resolution said to have been passed some years ago by the committee on agriculture, which requested that the Minister of Agriculture of the Dominion should invite the ministers of the different provinces in the Dominion to form themselves into a committee, whose object was to lay before the Government of Great Britain the importance of removing the cattle embargo. 3. Also showing what efforts, if any, have been made by the Minister of Agriculture to comply with the wishes of the above-named committee so expressed; together with a copy of the report, if any, of the same to the House, and what efforts have been so made; with what reason, if any, the Government assigns for not taking action in the matter. Presented 6th April, 1908.—*Mr. Armstrong*.. .. ..*Not printed.*

188. Census and Statistics, Bulletin V., Agricultural Census of Ontario, Quebec and the Maritime Provinces, 1907. Presented 6th April, 1908, by Hon. S. A. Fisher. .*Not printed.*

CONTENTS OF VOLUME 19—*Continued.*

189. Return to an address of the House of Commons, dated 30th March, 1908, for a copy of all memorials, documents, telegrams, and correspondence between the government of Prince Edward Island and the Government of Canada since 30th June, 1904, with respect to the non-fulfilment of the terms of union and for claims for damages in respect thereof. Presented 7th April, 1908.—*Mr. McLean (Queen's)*.. .. ..*Not printed.*

190. Return to an order of the House of Commons, dated 17th February, 1908, for a copy of all correspondence, telegrams, reports, memoranda, resolutions, and any other information in possession of the Government or any member or official thereof, respecting the construction of branch railway lines in Prince Edward Island. Presented 13th April, 1908.—*Mr. Martin (Queen's)*.. .. ..*Not printed.*

191. Return to an address of the House of Commons, dated 30th March, 1908, for a copy of all orders in council, reports, documents, correspondence and papers, from the 1st day of January, 1907, to the present time, relating to the passage of United States war ships or training ships through the St. Lawrence canals and Great Lakes, including a statement showing the number of United States war ships or training ships which have passed through the St. Lawrence canals during that period, and a statement of all such war ships or training ships now on the Great Lakes, and particulars of the tonnage, horse-power, armament and crew of such war ship or training ship, and of the naval reserves or other naval forces of the United States Government, or of any State Government upon the Great Lakes; also all correspondence respecting the proposed passage of the gunboat *Nashville* through the St. Lawrence canals and river on her way to the Great Lakes next summer. Presented 7th April, 1908.—*Mr. Taylor.*
Not printed.

192. Return to an address of the House of Commons, dated 29th January, 1908, for copies of all papers, representations, memorials and correspondence had with the Minister of Finance or any member of the Government in reference to the proposed action of the Government through or in conjunction with the banks, to facilitate in a financial way the movements of the grain from the western provinces of Canada. Presented 7th April, 1908.—*Mr. Foster*.. .. ..*Not printed.*

193. Return to an order of the House of Commons, dated 11th December, 1907, showing: 1. How many drill halls have been constructed or are under construction by the Government since 1896. 2. In what localities these buildings have been constructed, and the cost of construction in each case. 3. What military organizations exist in the respective localities in which these drill halls have been erected, and the numerical strength of each such military organization. Presented 7th April, 1908.—*Mr. Worthington.*
Not printed.

194. Return to an address of the House of Commons, dated March, 1908, for a copy of all orders in council and regulations made by the Governor in Council, or prescribed by the Minister of Customs under the provisions of chapter eleven (11) of the Acts of 1907, (6 and 7 Edward VII.), relating to materials to be used in Canada for the construction of bridges or tunnels crossing the boundary between the United States and Canada, and all similar regulations or legislative or administrative provisions of the United States Customs Laws relating to such materials. Presented 8th April, 1908.—*Mr. Clements*.. .. ..*Not printed.*

195. Return to an order of the House of Commons, dated 15th January, 1908, for a complete list of the publications in Canada enjoying the newspaper rate. Presented 8th April, 1908.—*Mr. Cockshutt*.. .. ..*Not printed.*

196. Partial Return to an order of the Senate, dated the 17th March, 1908, for a copy of the service-roll of the Garrison Artillery Companies of Ottawa and Morrisburg, giving names of the militiamen who were on active service, and who were in barracks at Fort Wellington, Prescott, during the months of November and December, 1865, and during the months of January, February, March, April, May and June, 1866; and also a

CONTENTS OF VOLUME 19—*Continued.*

statement showing what was the daily pay paid to the soldiers of these two corps and that which the militiamen belonging to Company No. 2 of the Ottawa Field Battery received at the same time, or that which was received by other corps of the Military District of Ottawa, which were also called out for active service. Presented 8th April, 1908.—*Hon. Mr. Landry*.. .. ..*Not printed.*

197. Return to an address of the House of Commons, dated 16th March, 1908, for a copy of all orders in council, reports, memoranda, agreements, contracts and other documents and papers of every kind, nature and description, from the 1st of January, 1900, up to the present time, relating to or touching the Dolkese or Dokis Indian reserve, or touching the surrender thereof of the timber thereon, and especially all such documents as aforesaid as relate to any proposals or arrangements for the surrender of any rights by the Indians in the said reserve or in the timber thereon, or to the sale or disposal of the said timber or any part thereof. Presented 9th April, 1908.—*Mr. Borden (Carleton). Not printed.*

197*a*. Supplementary return to No. 197. Presented 2nd July, 1908.. .. ..*Not printed.*

197*b*. Return to an order of the House of Commons, dated 23rd March, 1908, for a copy of all opinions of the Minister of Justice, or Deputy Minister of Justice, or any official of the Department of Justice, to the Minister of the Interior or any official of the Department of the Interior, with respect to the Metlakatla and Songhees Indian reserves, or either of the said reserves, since the 1st day of January, 1906. Presented 22nd April, 1908.—*Mr. Borden (Carleton)*.. .. ..*Not printed.*

197*c*. Return to an order of the House of Commons, dated 6th April, 1908, for a copy of all petitions, memorials, documents, correspondence and papers touching any matters, transactions or negotiations between the Department of Indian Affairs and the council of the Six Nations reserve, or the chief or chiefs of the said council or the Indian Rights Association or Warriors' Association, from the 1st day of January, 1906, to the present time. Presented 18th May, 1908.—*Mr. Lake*.. .. ..*Not printed.*

198. Return to an order of the House of Commons, dated 11th March, 1908, for a copy of contract and all correspondence in connection with purchase of cement from E. A. Wallberg, by the Department of Marine and Fisheries, to heighten Heath Point. Presented 13th April, 1908.—*Mr. Staples*.. .. ..*Not printed.*

199. Return to an order of the House of Commons, dated 19th February, 1908, showing: 1. What amount the firm of H. N. Bate & Co. has received from each department of the Government since the year 1896 for supplies, giving the amount paid each year separately. 2. What amount the firm of W. C. Edwards & Co. has received from each department of the Government since the year 1896 for supplies, giving the amount paid each year separately. Presented 13th April, 1908.—*Mr. Taylor*.. .. ..*Not printed.*

200. Return to an order of the House of Commons, dated 11th March, 1908, for a copy of all petitions, letters and applications, by or on behalf of "La Société Canadienne d'immigration et de placement," for assistance from the Government, and the answer by the Government or its officials to the same. Presented 13th April, 1908.—*Mr. Monk. Not printed.*

201. Return to an order of the House of Commons, dated 30th March, 1908, for a copy, as it appeared printed in the *Yukon World and Official Gazette* for nine months of the financial year 1906-7, of a synopsis of mining regulations referred to in the Auditor General's Report, 1906-7, at page L—37, and also setting forth the number of times the said advertisement appeared in the newspapers referred to in the time stated. Presented 13th April, 1908.—*Mr. Lennox*.. .. ..*Not printed.*

202. Return to an order of the House of Commons, dated 26th February, 1908, for a copy of all correspondence, leases or other papers in connection with the leasing or proposed leasing of Kananaski Falls, on the Bow river. A copy of all correspondence and other

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

whom purchased and whether by tender or otherwise. Presented 6th May, 1908.—*Hon. Sir Mackenzie Bowell*.. .. ..*Not printed.*

210. Return to an address of the Senate, dated 30th January, 1908, showing: 1. Has Mr. Michel Siméon Delisle, of the parish of Portneuf, in the county of Portneuf, merchant, and, since 1900, member of the House of Commons, at any time after the general elections of 1896, received any sum of money whatsoever coming from the federal treasury. 2. If so, when, how much, and for what object at each time. Presented 6th May, 1908.—*Hon. Mr. Landry*.. .. ..*Not printed.*

211. Return to an order of the House of Commons, dated 11th May, 1908, for a copy of the report made by Mr. Victor Gaudet as a result of the investigation held by him into charges preferred against E. Roy, foreman of works, under the Department of Marine and Fisheries; and of the evidence in connection therewith. Presented 11th May, 1908.—*Hon. L. P. Brodeur*.. .. ..*Not printed.*

212. Return to an order of the House of Commons, dated 9th March, 1908, for a copy of all correspondence, telegrams, reports, and all other information, not already brought down, in possession of the Government or any member or official thereof, in reference to winter communication, and the construction of a tunnel between Prince Edward Island and the mainland of Canada. Presented 2nd July, 1908.—*Mr. Martin (Queen's). Not printed.*

213. Return to an order of the House of Commons, dated 3rd February, 1908, for a copy of all tenders, contracts, correspondence, plans, specifications, certificates, schedules, and all other papers and documents, including settlement, agreements, claims or adjustments thereof, relating to the contract of Messieurs Murray & Cleveland to do the work at the eastern gap at Toronto Harbour, which work was completed in or about the year 1896. Presented 14th May, 1908.—*Mr. Macdonell*.. .. ..*Not printed.*

214. Return to an order of the House of Commons, dated 6th April, 1908, for a copy of all letters, telegrams, memoranda and correspondence of every kind between the Minister of Marine and Fisheries, or any officer of his department, and any person or persons, respecting the purchase of supplies for the Department of Marine and Fisheries at Quebec, St. John, New Brunswick and Halifax, during the years 1892, 1893, 1894, 1895 and 1896. Presented 14th May, 1908.—*Mr. Johnston*.. .. ..*Not printed.*

215. Copy of a treaty between Great Britain and the United States concerning the fisheries in waters contiguous to the Dominion of Canada and the United States, signed at Washington on April 11, 1908. Presented 19th May, 1908, by Sir Wilfrid Laurier. *Printed for both distribution and sessional papers*

215*a*. Correspondence, orders in council and despatches in connection with the negotiation of a treaty between Great Britain and the United States concerning the fisheries in waters contiguous to the Dominion of Canada and the United States. Presented 4th June, 1908, by Sir Wilfrid Laurier...*Printed for both distribution and sessional papers.*

216. Return to an order of the House of Commons, dated 29th January, 1908, showing the total expenditure by the Department of Public Works in Prince Edward Island over the following periods: 1873 to 1878; 1878 to 1896; 1896 to 1907; and the total expenditure by the Public Works Department in Prince county over periods 1873 to 1878; 1878 to 1882; 1882 to 1887; 1887 to 1891; 1891 to 1896; 1896 to 1900; 1900 to 1907, respectively. And the expenditures by the Public Works Department in the counties of Queen's and King's for the years and the periods of years above-mentioned. Also the total expenditures in said province by the Post Office Department, the Department of Railways and Canals, and the Department of Militia and Defence. And further, the total expenditures by the Department of Marine and Fisheries, including the development, propagation and preservation of the fisheries, and in the maintenance of winter communication across the Northumberland Straits, for the years and periods of years above referred to. Presented 26th May, 1908.—*Mr. Lefurgey*.. .. ..*Not printed.*

CONTENTS OF VOLUME 19—*Continued.*

217. Return to an order of the House of Commons, dated 11th December, 1907, for a copy of all correspondence, contracts and appointments of overseers in respect to Port Burwell Harbour, in the county of Elgin, Ontario, since 1st January, 1907; also a return showing pay-sheets, amount of new material used, from whom purchased, of all day or contract work on the said harbour, giving names of overseers and by whom appointed for the same. Presented 26th May, 1908.—*Mr. Marshall.. .. ..Not printed.*

218. Return to an order of the House of Commons, dated 6th May, 1908, showing the names of all persons who furnished supplies to the steamer *Petrel* between the 31st March, 1907, and 30th April, 1908, the amount paid to each such person, and the date of each payment. Presented 4th June, 1908.—*Mr. Chisholm (Huron).. .. ..Not printed.*

219. Return to an order of the House of Commons, dated 19th February, 1908, (*a*) showing the revenue contributed by the province of British Columbia for each and every year from 1872-3 to 1905, inclusive, under the following heads: 1. Customs. 2. Chinese Immigration. 3. Inland Revenue, Excise, Weights and Measures, Gas Inspection, Electric Light Inspection, Methylated Spirits, Sundries. 4. Post Offices. 5. Public Works, Telegraphs, Esquimalt Graving Dock, Casual. 6. Experimental Farm. 7. Penitentiary. 8. Marine and Fisheries, Sick Mariners' Fund, Steamboat Inspection, examination of Masters and Mates, Casual and Harbours, Fisheries. 9. Superannuation. 10. Dominion Lands and Timber. 11. Vancouver Assay Office. 12. Miscellaneous. 13. Public Debt. 14. Any other source. And (*b*)showing expenditure by the Dominion of Canada on account of the province of British Columbia, for each and every year from 1872-3 to 1905, inclusive, under the following heads : 1. Public Debt. 2. Charges of Management. 3. Lieutenant Governor. 4. Administration of Justice, Judges, &c. 5. Penitentiary. 6. Experimental Farm. 7. Quarantine. 8. Immigration. 9. Pensions, &c. 10. Militia. 11. Public Works, Buildings, Harbours and Rivers, Dredging. 12. Telegraphs, Agency. 13. Mail subsidy. 14. Marine and Fisheries, Dominion Steamers, Lighthouses, Meteorological Marine Hospital, Steamboat Inspection, Miscellaneous, Fisheries, Fisheries Inspection, Hatcheries. 15. Indians. 16. Subsidies. 17. Dominion Lands. 18. Customs. 19. Inland Revenue, Excise, Weights and Measures, Gas and Electric Light. 20. Esquimalt Dry Dock. 21. Post Office. 22. Chinese Immigration. 23. Defences, Esquimalt. 24. Chinese Immigration Inquiry. 25. Bounty on Minerals. 26. Miscellaneous. 27. Vancouver Assay Office. 28. Railway Subsidies. 29. Any other source. Presented 10th July, 1908.—*Mr. Ross (Yale-Cariboo)..Printed for distribution.*

220. Return to an order of the House of Commons, dated 3rd February, 1908, showing during the last ten years how much money has been expended by years by this Government for printing and lithographing done outside of Canada; and for what reason such work was done out of Canada. Presented 4th June, 1908.—*Mr. Macdonell..Not printed.*

221. Return to an order of the House of Commons, dated 5th June, 1908, for a copy of the evidence taken in the *Montcalm-Milwaukee* collision case, and a copy of the decision of the wreck commissioner and of the assessors on the collision. Presented 5th June, 1908.—*Hon. L. P. Brodeur.. .. ..Not printed.*

222. Return to an order of the House of Commons, dated 13th January, 1908, for the production of the following: 1. A copy of the appointment of Doctor Edmond Savard, of Chicoutimi, as paymaster for the county of Chicoutimi. 2. A copy of the instructions given to him as such regarding the validity of the receipts. 3. A copy of all correspondence that took place between Doctor Edmond Savard and the Department of Public Works of Canada in regard to the St. Fulgence pier, in the county of Chicoutimi. 4. A copy of all correspondence that took place between the Auditor General and the Department of Public Works regarding the said Doctor Edmond Savard, paymaster, concerning the St. Fulgence pier. 5. A copy of all the pay lists in connection with the said St. Fulgence pier during the period of time that the said Doctor Savard

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Continued.*

CONTENTS OF VOLUME 19—*Concluded.*

DEPARTMENT OF THE INTERIOR

REPORT

OF THE

CHIEF ASTRONOMER

FOR THE

YEAR ENDING MARCH 31

1907

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
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1908

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CONTENTS

LIST OF ILLUSTRATIONS.

Appendix 2.—Otto Klotz, LL.D.—Gravity, Seismology and Magnetics.

Appendix 3.—J. S. Plaskett, B.A.—Astronomical and Astrophysical Work.

Appendix 4.—R. M. Stewart, M.A.—Time Service.

REPORT OF THE CHIEF ASTRONOMER AND INTERNATIONAL BOUNDARY COMMISSIONER.

DEPARTMENT OF THE INTERIOR,
DOMINION ASTRONOMICAL OBSERVATORY,
OTTAWA, CANADA, July 1, 1907.

W. W. CORY, Esq.,
Deputy Minister of the Interior,
Ottawa.

SIR,—I have the honour to report as follows upon the work of the Astronomical Branch of the Department of the Interior, and of the International Boundary Surveys for the nine months ending March 31, 1907.

The correspondence of the branch from July 1, 1906 to March 31, 1907 was:—

Letters received (exclusive of circulars)	964
Letters sent " "	2,008

Showing an increase over the previous fiscal year of 23½ per cent.

Accounts dealt with	743

Increase, 47½ per cent.

A statement of the work of the photographic division is appended. (Appendix No. 1.)

The library now contains 2,469 bound volumes, besides numerous pamphlets. The increase is rapid from the addition of scientific journals, reports of other observatories, &c. To meet the increase a large addition to the shelving is being made by the Department of Public Works.

The workshop has proved most useful. The appointment of a mechanician, last July, has enabled many improvements as well as repairs to be made to instruments, resulting in economy in both time and money. Repair work in the building obviates the necessity of sending an instrument away, which may involve the interruption of a series of observations, while the construction of apparatus to a required design, and under the direct supervision of the designer, is a most valuable feature. Construction has not been confined to minor apparatus; a spectrograph specially adapted to determination of radial velocities has been constructed. A description of this instrument, which was designed by Mr. Plaskett, will be found in his report appended hereto. A registering micrometer for attachment to one of the transit instruments is now in course of construction.

The Observatory has joined the 'astronomical exchange.' At the Observatory of Harvard University is a central bureau for the receipt from observers all over the continent of reports of any discoveries or notable observations which they may make. These reports are telegraphed to the observatories which are members of the exchange, and are of service in keeping the members of the staff informed on current astronomical matters. A well devised cipher enables a great deal of astronomical information to be conveyed in a short telegram.

In December, a section of the Royal Astronomical Society of Canada, comprising now over one hundred members, was formed. Fortnightly meetings were held in the Observatory during the winter, at which papers on astronomical subjects were read and discussed. These meetings have been of great service to the members of the staff, by the interchange of ideas, and they have also evoked much public interest.

The number registering in the Visitors' Book, has been 2,688, during the nine months ending on March 31, last. Many of these have called during the day, to see the 15-inch telescope and other instruments, including the, to many, more interesting apparatus, that by which the time system is operated.

On Saturday nights, the public is admitted to view the heavens through the large telescope. Members of the Astronomical Society also have this privilege on the nights of meeting.

It has been necessary to refuse the applications which occasionally are made to look through the telescope on other nights. The instrument is in use on every clear night, with the spectroscope or other auxiliary instrument attached, and to grant a request to see through the telescope would necessitate replacing the attachment by the visual eye-piece, and an adjustment of the counterpoises, with a resulting loss of time which would be fatal to regularity of observations.

The transit instrument is still housed in the temporary shed to the east of the main building, the western wing, built to accommodate this instrument as well as the meridian circle, not having yet been completed. Work, however, is now progressing upon the piers for the instruments, and on the roof of the wing. The meridian circle has not yet been received from the makers.

It is expected that work will soon be commenced on the coelostat house, and the house for standardizing measures of length. The plans and specifications have been completed by the Public Works Department and it is expected that tenders will be called for in the near future. Both buildings are much needed.

The astrophysical work has been continued under the direction of Mr. Plaskett. It has comprised, mainly, observation of velocities of stars in the line of sight for determination of the orbits of spectroscopic binaries; also, solar photographs for record of sun-spot areas. Micrometric work on double stars has been begun. Mr. Plaskett has undertaken investigations of the errors entering into spectrographic work. He has also prepared drawings of mechanism for coelostat telescope, of house for the same, and of various instruments, an account of which will be found in his report hereto appended. In the summer of 1906 he visited a number of observatories at which spectrographic work is carried on, with a view to familiarizing himself with the processes employed.

Daily records are obtained from the seismograph of earth movements. The large scale of the record (90 c.m. per hour) is of advantage in the accurate determination of the time of disturbances. A discussion by Dr. Klotz of these observations, and their scientific bearings, will be found in his report.

Arrangements have been made for commencing during the present summer, systematic observations of the magnetic elements at various points, as well as observations for gravity with the half-seconds pendulum, in continuation of the observations with this apparatus made by Dr. Klotz some years ago at Ottawa, Toronto and Washington, and at points on the route of the transpacific cable.

The time service has worked satisfactorily. There are now 215 dials operated under the system of control from the Observatory, described in previous reports, with one tower clock (at the Observatory). A system of twenty dials and a tower clock will shortly be in operation in the Post Office, and provision is being made for 29 dials in the Printing Bureau, 29 in the Mint and 7 in the Archives Building. The Ottawa Electric Company have offered to place, at their own expense, a large dial in front of their office on Sparks Street, to be operated from the post office circuit. Some improvements have been made in the mechanism for sending the noon signals.

The time-keeping of the standard sidereal clock at the Observatory has been brought to a high degree of perfection by means of an automatic temperature regulation through a Callendar recording (and controlling) thermometer. A description of this instrument will be found in the appended report by Mr. Stewart on the time system.

My last report, dated October 9, 1906, brought the account of the field astronomical work for the determination of latitudes and longitudes up to the close of last summer's operations. Necessarily there is nothing to report as to the occupation of new stations, since this work cannot be done in winter. In April, last, Mr. F. A. McDiarmid, who is our principal field astronomer, was detailed to accompany an officer of the United States Coast and Geodetic Survey to the 141st meridian, at the Yukon river, to observe an initial azimuth for the survey of that meridian. As a better determination of latitudes and longitudes of points on the Yukon river has long been a desideratum, it was thought advantageous that Mr. McDiarmid's services, while he was in that region should be utilized, after he had completed the azimuth work, in the determination of the geographical positions of various points between the boundary at the 141st meridian and the boundary at White Pass, including Dawson. Mr. W. C. Jaques was detailed as the second observer.

Arrangements have also been made for the observation of the geographical co-ordinates of several points in Ontario, Quebec and the maritime provinces, for cartographical purposes.

The trigonometrical survey of Canada is being continued. Owing to the unusually late spring this year, operations were much delayed, although reconnaissance was made by Mr. Bigger, during the winter, eastward as far as the boundary of New Hampshire, and at this date, the selection of angular points has been completed between this point and a meridian about 30 miles west of Ottawa. The building of observing scaffoldings where necessary at the angular points has been almost completed over this whole extent, and observing is now proceeding.

Lines of level are being run over the principal railway lines in the eastern townships to connect with the levels which are being carried along the international boundary line (45th parallel). Two parties are engaged on this work.

At the request of the Militia Department a connection is being made with the United States Lake Survey primary stations on the Niagara peninsula, with a view to triangulating across the lake to the neighbourhood of Toronto. This connection will afford a basis for the topographic work of that department around Toronto.

It is my painful duty to record the death of Mr. J. D. McLennan, D.L.S., who was employed on the triangulation for two years, 1905 and 1906. His health failing, he was compelled to apply for sick leave last winter. He died at his home, at Port Hope, on April 19, 1907.

In pursuance of an order in council, dated November 13, last, a committee was formed of representatives of the departments which conduct surveys, to consider what steps, if any, should be taken towards the systematizing of surveys for topographical purposes.

The committee was composed of seven departmental representatives, together with representatives of the Universities of Toronto, McGill and Laval. The undersigned was elected chairman of the committee, which held frequent meetings in December, January and February, and completed its report on February 15.

In my last report an account was given of the observations for longitude preparatory to the survey of the 141st meridian. As already stated, before the opening of navigation on the Yukon, Mr. McDiarmid was sent to the point where the meridian crosses the Yukon river to locate, in co-operation with Mr. Baldwin, of the United States Coast and Geodetic Survey, the initial point of the meridian by measurement from his observing station of last year, and to lay down the meridian of that point, to be produced southward by the line surveyors.

Mr. A. J. Brabazon, in charge of the Canadian section of the line surveying party, followed at the opening of navigation. It is intended to produce the line south as rapidly as possible in order to reach the mining region near the White river before winter, if possible. A topographical survey will be made extending two miles on each side of the line, based upon a triangulation.

The demarcation of the boundary of the Alaska Coast strip is proceeding as usual. Mr. J. D. Craig, D.L.S., is working on the line back of Bradfield canal, and Mr. W. F. Ratz, D.L.S., is marking the boundary line at Taku and Whiting rivers, and making an exploratory survey of the unmapped region east of Stephens passage, in order that the commissioners may be able to decide (in accordance with the agreement of March, 1905) which peaks should determine the boundary line. Each of these surveyors is accompanied by a representative of the United States commissioner.

Mr. D. H. Nelles, D.L.S., accompanies, as my representative, an American party under Mr. Fremont Morse. This party is engaged in making a triangulation up Glacier bay, in order to determine the geographical positions of the mountains on the boundary line westward from the termination of the survey made two years ago by Mr. Ratz, south of the Salmon river. One peak is especially important, the first peak east of the Alsek river, for between it and the next peak west, as determined by the Tribunal, there is a stretch of 50 miles. Hence the proper identification of this peak, and the determination of its geographical position is most important. An attempt was made last year to reach it from the other side, by way of the Alsek, but it was not identified with certainty.

Another United States party is working to the east of Lynn canal.

The survey of the 49th parallel is being continued by Mr. J. J. McArthur, D.L.S. Of the part of this line west of the summit of the Rocky mountains, there remains to be completed but a few miles in the foothills of the Cascade range. This will be completed this year.

I have arranged for a tour of inspection of this line in company with the United States Commissioners, Mr. Tittmann and Dr. Walcott. We start in a few days.

The survey of the Eastern section of the boundary line (from the Richelieu river to the St. Croix river) is proceeding under Mr. G. C. Rainboth and Mr. J. B. Baylor, the Canadian and United States engineers, respectively. The work, which consists of a resurvey of the line and the placing of new monuments, was begun last August at Hall's stream, at the northeastern corner of the State of Vermont. It is expected to reach Richelieu river by the close of the present season.

A survey of the international boundary line was made at Portal, on the C.P.R. at the southern boundary of the province of Saskatchewan.

The boundary line (the 49th parallel) had been surveyed in this locality by the Joint Commission of 1872-75, but the nearest original monuments were at some distance on each side of the railway station, where a closer definition of the line was desired on account of a question of jurisdiction which had arisen.

In October, 1906, I gave Mr. C. A. Bigger instructions to perform the demarcation in co-operation with Mr. O. B. French of the United States Coast and Geodetic survey, who was detailed by Mr. Tittmann, the American Commissioner, for the work. The survey was accordingly made, and the line marked with iron bolts driven into the ground, and by nails in the station platform. The demarcation was approved by Mr. Tittmann and myself in a joint report dated November 23, 1906, which has been accepted by the two governments.

Appended hereto will be found the following statements and reports:—

Appendix 1.—Report of work done in the photographic division.

Appendix 2.—Report by Otto Klotz, LL.D., on gravity, seismology and magnetics.

Appendix 3.—Report by J. S. Plaskett, B.A., on astronomical and astrophysical work.

Appendix 4.—Report by R. M. Stewart, M.A., on time service and transit observations.

Appendix 5.—Observations for latitude and longitude.

I have the honour to be, sir,
Your obedient servant,

W. F. KING,
Chief Astronomer
and International Boundary Commissioner.

APPENDIX 1

REPORT OF THE CHIEF ASTRONOMER, 1907.

STATEMENT OF WORK PERFORMED IN THE PHOTOGRAPHIC DIVISION

APPENDIX 1.

STATEMENT of work done in the Photographic Division between the 1st July, 1906, and the 31st March, 1907.

	Size of Prints, Negatives, &c.														Total.
	In. 3¼ x 5½	In. 4 x 5	In. 4¾ x 6½	In. 5 x 7	In. 8 x 10	In. 10 x 14	In. 14 x 17	In. 16 x 20	In. 20 x 24	In. 8 x 36	In. 28 x 36	In. 30 x 40	In. 40 x 60	In. 3 x 14	
Survey plates developed			914	132											1,046
Films developed	200	220													420
Copies, maps and plans					46		7	29							82
Lantern slides and transparencies		202													202
Black and white and blue prints							24	17	10		30	25	10		116
Bromide prints						1,149	11	78	8	48					1,294
Argo paper prints (contact)		405	130	2,306	292										3,133
Seismograms developed										274					274
Star spectrum plates enlarged														12	12
" print enlargements														18	18
Sun observation plates developed					145										145
Platinum prints				75											75
Total	200	827	1,044	2,513	483	1,149	42	121	18	322	30	25	10	30	6,817

J. D. WALLIS,
Photographer.

APPENDIX 2.

REPORT OF THE CHIEF ASTRONOMER, 1907

GRAVITY, SEISMOLOGY AND MAGNETIC WORK

BY

OTTO KLOTZ, LL.D.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 2.

GRAVITY, SEISMOLOGY AND MAGNETIC WORK, BY OTTO KLOTZ, LL.D.

W. F. King, Esq., B.A., LL.D.,
Chief Astronomer,
Department of the Interior,
Ottawa.

Ottawa, Ont., July 1, 1907.

Sir,—I have the honour to make the following report of the work carried out under my charge, which may be classified under three different headings:—Gravity, Seismology and Magnetics.

GRAVITY.

The pendulum observations made by me with our half-seconds apparatus at McGill University, where previously Commandant Defforges of Paris had observed, and at the School of Practical Science, Toronto, are given in abstract; by comparison with my observations taken at the international base station of the United States Coast and Geodetic survey, Washington, I was enabled to give satisfactory absolute values for gravity.

The most interesting and valuable gravity observations taken by me are those in the South Seas at Suva, Fiji, and those at Doubtless bay, at the northern extremity of New Zealand. The importance is two-fold; in the first place the vast Pacific is more or less a virgin field for gravity work, and in the second place the number of gravity stations in the vastly greater water-area of the globe is very limited, so that the anomalies of gravity deduced from theoretical considerations based on latitude and an assumed ellipsoid of revolution from geodetic and pendulum measures, are known only for a relatively small part of the earth's surface. The results obtained therefore from ocean stations are at present of far greater value than for those on land.

Advantage was taken of the Eclipse expedition to Northwest river in August, 1905, under your charge to obtain gravity observations there. These were carried out by Professor L. B. Stewart, and are given in abstract together with the reduction to absolute value based on my Washington observations with the same pendulums.

The observations for gravity at the five stations, Montreal, Toronto, Suva (Fiji), Doubtless Bay (New Zealand), and Northwest river were made with the half-seconds pendulum apparatus described in my report for 1905.

Each of the three pendulums was swung for about eight hours in one position and then for a similar time in the reversed position. Time observations, the interval between which serves as a scale expressed in sidereal seconds for determining the period of a pendulum, were obtained at the beginning, at the end, and during the swings of the pendulums. Two sidereal chronometers were always used by me, except for Montreal, where the standard sidereal observatory clock was used, for noting coincidences, and one of them was used for the time determinations. The latter were always obtained from two positions of the transit, circle east and circle west, and the transits recorded on the chronograph. A comparison of the two chronometers was generally made three times a day and on the chronograph so that a good differential rate between the two time pieces was obtained. This differential rate was interpolated for the middle time of each swing for obtaining the rate correction for the period. In order to make this part of the report complete in itself, it will be well to repeat briefly the method of reduction of the observations. The lengths of the pendulums, upon which the period depends, are supposed to be invariable except as affected by temperature. As a test of invariability they are generally swung again at a base station after a pendulum campaign. Gravity observations with a half-seconds pendulum apparatus give only differential values for the acceleration of gravity, that is, a comparison is made of the period of a pendulum, or of the 'mean pendulums,' which is the mean of the several pendulums swung, at a given station with that at a base station for which the absolute value is known. Washington, where the pendulums were first swung, is the base station for the following observations.

In order to make the periods comparable with those obtained with the same pendulums at other times and stations, it is necessary to reduce them to certain standard conditions. These conditions, which are arbitrarily adopted are: an infinitely small arc; temperature 15° C; pressure 60^{mm} of mercury at 0° C; true sidereal time; and inflexible support.

Arc Correction.—Were the pendulums swinging for a very brief time only, the reduction might be made from the observed arc or amplitude. We would then have

$$t = t_0\left(1 + \left(\tfrac{1}{2}\right)^2 \sin^2\frac{a}{2} + \left(\frac{1\cdot 3}{2\cdot 4}\right)^2 \sin^4\frac{a}{2} + \left(\frac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\right)^2 \sin^6\frac{a}{2} + \ldots\ldots\ldots\ldots\right)$$

where t_0 = reduced time or time for infinitely small arc, t = observed time, and a = the amplitude or half of total arc.

The above expression reduces to

$$t = t_0\left(1 + \frac{a^2}{16} + \frac{11\,a^4}{3072}\ldots\ldots\ldots\ldots\right) \quad a \text{ being in radians,}$$

from which

$$t_0 = t\left(1 - \frac{a^2}{16} + \frac{a^4}{3072}\ldots\ldots\ldots\ldots\right)$$

As a is generally less than 3°, the term containing the fourth power may be omitted and we obtain

$$t_0 = t\left(1 - \frac{a^2}{16}\right) \qquad (1)$$

This reduction pertains to a uniform arc, or when the swing is of short duration, and for such may be put in the form, $t_0 = t\left(1 - \frac{a'\,a''}{16}\right)$, where a' and a'' are respectively the arcs at the beginning and end of a swing.

This latter form is the one used in the reduction of the oscillations of a magnet.

When, however, the swing continues for a considerable time, formula (1) is no longer applicable.

On the assumption that the amplitude decreases in geometrical ratio, the relation between amplitudes is $a = a_1 e^{-kt}$, where k is the logarithmic decrement, t the time interval and e the base of the natural logarithms. For reduction, the adaptation of Borda's formula is,

$$\text{arc correction} = -\frac{P\,M}{32}\;\frac{\sin(\phi+\phi')\,\sin(\phi-\phi')}{\log\sin\phi - \log\sin\phi'}$$

where P is the period of the pendulum in seconds, M the modulus of the common logarithmic system, ϕ and ϕ' the initial and final semi-arcs respectively.

Temperature Correction.—The coefficient necessary for this correction was determined experimentally at Washington with pendulums of the same material and construction as those of our apparatus, by swinging the pendulums at temperatures differing about 20° C, and obtaining the periods for the different temperatures.

From these experiments the formula for correction for temperature was derived.

Temperature correction = + ·00000418 (15° − T°), where T° is the temperature of the 'dummy' pendulum within the air chamber in degrees Centigrade.

Pressure Correction.—The air chamber during a swing is exhausted to about 60^{mm} pressure, and the swings are reduced to this pressure. From observations by G. R. Putnam, at Washington, in 1894, the

$$\text{pressure correction} = +\,{\cdot}000000101 \left[60 - \frac{Pr}{1 + {\cdot}00367\ T^\circ} \right]$$

where Pr is the mean of the observed pressures at the beginning and end of the swing, and T° the mean temperature of the pendulum during the swing. The expression $\frac{Pr}{1 + {\cdot}00367\ T^\circ}$ is simply a reduction of the air pressure to a temperature of 0° Centigrade.

Rate Correction.—In field observations very good time determinations are obtained with the astronomic transit, chronometer and chronograph; the comparisons between the chronometers, three times daily, on the chronograph for differential rate are very satisfactory, yet for absolute rate we are dependent upon one or other of the chronometers keeping a uniform daily rate as deduced from the time observations. The fluctuations of the rate during the 24 hours must be sought mainly in the change of temperature, which it is very difficult to maintain uniform in an observing hut, ten feet square.

As there are 86,400 sidereal seconds in a day, if R is the daily rate then the correction per second $= \frac{R}{86400} = {\cdot}000011574\ R$, and for a period P

Rate correction = ·000011574 RP

For a chronometer gaining the correction is subtractive, and for losing additive.

Flexure Correction.—As all the observations to date with one exception have been made on solid stone piers detached from the immediate floor, the flexure correction is small and practically constant. From observations made statically by means of a weight, 1·5 kilogrammes, the following formula is derived:—

Flexure correction = ·00000065 D, where D is the displacement of the knife-edge in microns.

Applying the above four corrections, the periods of the pendulums are obtained and expressed in sidereal seconds. The acceleration of gravity, or g, is expressed, however, in terms of a mean time second. For differential gravity observations it is quite immaterial which time, sidereal or mean, we employ, as the ratio between them would remain the same in the deduction of the unknown g from the relation $P_0^2 : P^2 = g : g_0$ where P_0, g_0 pertain to the base station.

A word about the theoretical value of g.

In 1743 was published Clairaut's celebrated work 'Theorie de la Figure de la Terre,' in which is given his famous theorem: $\frac{g' - g}{g} = \frac{5}{2} m - e$ (2)

where g' and g are respectively the values of gravity at the pole and equator, m the ratio of the centrifugal force at the equator to gravity, and e the ellipticity of the meridian or flattening.

Furthermore for any latitude $g_\phi = g \left\{ 1 + \left(\frac{5}{2} m - e \right) \text{Sin}^2 \phi \right\}$ for sea level. (3)

Todhunter* says: 'The assumptions on which Clairaut's demonstration of his famous theorem rests should be carefully noticed. The strata are supposed to be ellipsoidal, and of revolution round a common axis, and nearly spherical. Each stratum is homogeneous, but there is no limitation on the law by which the density varies from stratum to stratum: the density may change discontinuously if we please.

* History of the Theories of Attraction and the figure of the earth. Vol. 1, p. 221.

It is not assumed that the strata were originally fluid; but it is assumed that the *superficial* stratum has the same form as if it were fluid and in relative equilibrium when rotating with uniform angular velocity. There is no limitation on the law by which the ellipticity varies from stratum to stratum, except that the ellipticity must be continuous, and at the surface must be such as would correspond to the relative equilibrium of a film of rotating fluid.'

Fundamentally Clairaut's theorem is used to-day, it is simply a matter of substituting values for g, m and e, and the different values adopted for these latter constitute practically the differences between different formulas that we have for the theoretical determination of the value of g_ϕ. As data accumulate slight modifications in the constants are made.

Another form of expressing (3) is $g_\phi = g_{45}$ $(1 - \text{B Cos } 2\phi)$, in which form Harkness gives $g_\phi = 980{\cdot}60\ (1 - {\cdot}002662 \text{ Cos } 2\,\phi)$* (4)

The most recent accurate general formula for sea-level is that of Helmert

$$g_\phi = 978{\cdot}046\ (1 + {\cdot}005302 \text{ Sin}^2\ \phi - {\cdot}000007 \text{ Sin}^2\ 2\phi)\dagger \qquad (5)$$

This formula differs from Helmert's 1884 formula principally in the new value 978·046 for equatorial gravity, instead of 978·000.

It has been found that the actual figure of the earth as determined by the surface of the oceans differs but very little from a figure of revolution, the differences that are found, however, from Clairaut's assumption are the deviations from homogeneity in the distribution of the matter of the earth. The difference between the observed value of g at or near sea-level and the computed one (5), dependent upon the latitude gives the 'anomaly.'

In the reduction to sea-level, that is, merely for height of stations, we have directly, from theoretical consideration that gravity varies inversely as the square of the distance, the change in g due to an elevation h, where h is small compared with the radius r of the earth, equal to $\frac{2\,h}{r}$ hence formulae (3), (4), (5) obtain the additional factor $\left(1 - \frac{2\,h}{r}\right)$. Putting $r = 6{\cdot}378 \times 10^6$ metres, we find that 33 metres elevation decreases gravity by $^{\text{cm}}{\cdot}01$, which Helmert expresses as $^{\text{cm}}{\cdot}0003086\ H$, where H is in metres. This reduction is simply for elevation and disregards the matter lying between the station and sea-level.

If we take into consideration the matter lying between the station and sea-level, and on the assumption that it extends indefinitely in a horizontal plain or is a shell of depth H, then gravity is increased by $\frac{3\,H}{r}\,\frac{\delta}{\triangle}$, where δ is the density of the matter above sea-level, and $\triangle$ the mean density of the earth. Any deviation from the latter condition by mountain masses above the station, or valleys beneath the same will decrease the gravity at the station and hence a correction, 'the topographical' correction, making a third term to the above two is introduced, it has the positive sign. When this term is introduced topographical sheets are necessary and some value for density must be assumed.

It must be admitted that with reference to these latter reductions considerable uncertainty is involved dependent upon the assumptions involved and the constants adopted.

Professor Everett says: 'The reduction for elevation is largely a matter of guesswork; and in records of observations the actual values are much more important than the so-called 'values reduced to sea-level.'

For deducing the absolute value of g for a station, we have the relation with reference to the base station at Washington, $P_w^2 : P^2 = g : g_w$ (6)

* Smithsonian Geographical Tables 1897—Appendix.—

† 'Der normale Teil der Schwerkraft im Meeresniveau.' K. Preuss. Akad. der Wissenschaften zu Berlin. 1901 S. 336.

In this reduction, as formerly, g_w is taken at 980·098 dynes, this value when similarly applied to Potsdam, for observations with the same three half-seconds pendulums, gives for the latter $g_p = 981·261$, while the absolute determination by an elaborate series of reversible seconds pendulums gives* $g_p = 981·274$, a difference of ·013. For any of the following deduced values of g by adding ·013 we obtain a value based on Potsdam.

Corrections to thermometers, as tested at Washington Bureau of Standards. Test No. 229, December 27, 1902.

SCALE.	CORRECTIONS.	
C	Green 136.	Green 121.
°	°	°
0·0	−·10	−·20
5·0	−·10	−·10
10·0	−·10	−·15
12·5	−·15	−·15
15·0	−·15	−·15
17·5	−·15	−·20
20·0	−·15	−·20
22·5	−·15	−·15
25·0	−·20	−·20
27·3	−·20	−·20
30·0	−·20	−·20
32·0	−·20	−·20
35·0	−·20	−·20
40·0	−·20	−·20

That is, the Green thermometers read too high.

Montreal.—Pendulum apparatus was mounted on and cemented to a solid brick pier 2′ 5″ x 3′ 5″ and 3′ above the floor, slate top. The pier was 27 feet west of the pier on which Commandant Defforges observed in 1893, being in the north basement of the Physics building, McGill University. Latitude of station 45° 30′ 22″ (McLeod), longitude 73° 34′; elevation 131 ft. (40^m).

A telegraph line was strung between the nearby McGill College observatory, connecting the sidereal observatory clock with the flash apparatus. Professor McLeod, director of the observatory, kindly supplied the daily rate of the clock.

It may be noted that in the report† of Commandant Defforges for his Montreal observations he gives the height of the station as 100 metres instead of 40 metres, the actual height. Hence his reduced value for g requires a correction for the erroneous height.

Toronto.—Here the apparatus was set up in the southeast basement of the School of Practical Science. It was mounted on and cemented to the comparator stand, a solid steel structure on firm foundation and free from the floor. Latitude of station 43° 39′ 35″, longitude 79° 24′; elevation 349 ft. (106^m). Professor L. B. Stewart observed for time and the daily rates of the chronometers were deduced therefrom.

Suva.—This station was primarily occupied as a longitude station in the series 'Transpacific Longitudes,' given in the report of the Chief Astronomer for 1905.

Adjoining the transit hut was erected another one 7 feet square and in it a concrete pier was built 2 feet square, 5 feet high, and rising two feet above the floor. The circulation of the air was facilitated by an opening 3 inches wide between the

* "Bestimmung der absoluten Grösze der Schwerkraft fur Potsdam mit Reversionspendeln"—Berlin, 1906.

† Translation in United States Coast and Geodetic Report, 1894.

roof and the walls. The flash apparatus was in the transit hut and a small opening in the board partition permitted coincidences to be noted. The two chronometers were kept in the 'artificial line' cabinets within the contiguous cable building, in order to assure as uniform a temperature as possible, and was satisfactory under the circumstances, the range for the twenty-four hours being confined to about two degrees Fahrenheit. In the huts where the range of temperature is greater, it is (in the tropics) far less than in the temperate zone, where in our observing (transit) huts the temperature in the summer during the day-time readily runs up to 100° F. and more. Latitude of station—18° 08′ 45″, longitude 178° 25′ 36″ E, elevation 2^{m}+.

Time observations were made with the astronomic transit as in longitude work, observing clamp east and clamp west, recording on the chronograph, on which also the chronometers were compared.

From the transit observations, the daily rate of Bond 516 is found to be uniform, $-1^{s}·60$ (gaining), which is adopted, and from the three daily comparisons of the two chronometers, the varying rate of Dent 48,419 is deduced. Although the rate of Dent varies considerably during the 24 hours, yet by the frequent comparisons of the two chronometers, a good differential rate is obtained and from it the rate is interpolated for the middle time of swing; as the periods by the two chronometers show, a satisfactory result is obtained by this interpolation.

Date.	Dent 48419	Bond 516	D—B	Difference corrected for Bond rate.	Dent. At time.	Dent. Daily rate	Middle time of pend. swing.	Dent daily rate during swing.	Swing No.
1903	h. m. s.	h. m. s.	s.	s.	h. m.	s.	h. m.	s.	
July 10	7 29 00	7 29 08·69	− 8·69						
" 12	17 04 00	17 04 10 52	−10·52	−12·53					
					22 00	−1·92	22 00	−1·92	1
" 13	2 56 00	2 56 10·39	−10·39	−11·18					
					7 07	−1·14	6 08	−1·23	2
" 13	11 19 00	11 19 10·55	−10·55	−10·95					
					14 46	−1·53	14 06	−1·50	3
" 13	18 13 00	18 13 10·57	−10·57	−11·01					
					22 27	− ·85	21 48	− ·90	4
" 14	2 41 00	2 41 10·83	−10·83	−11·13					
					6 41	− ·36	6 06	− ·40	5
" 14	10 41 00	10 41 11·24	−11·24	−11·36					
					14 59	−1 09	14 16	−1·03	6
							22 32	− ·48	7
" 14	19 17 00	19 17 11·42	11·42	−11·81					
					3 22	− ·09	6 11	− ·70	8
" 15	11 27 00	11 27 12·44	−12·44	−12·50					
					15 35	2 73	14 38	−2·52	9
" 15	19 43 00	19 43 12·05	−12·05	12·99					
					23 56	−2 02	23 09	−2·09	10
" 16	4 09 00	4 09 11·90	−11·90	−12·61					
					7 59	1·53	7 24	−1·57	11
" 16	11 49 00	11 49 11·92	−11·92	−12·41					
					15 46	−3·12	15 15	− 3·02	12
" 16	19 44 00	19 44 11·42	−11·42	−12·45					

Doubtless Bay, N.Z.—Here, as in Suva the pendulum observations were made after completing the longitude determinations.

In the store-house of the Pacific Cable Company, was built a solid concrete-brick pier of the same dimensions as the one at Suva, and on it the apparatus was mounted, the footplates of the air-chamber being as usual cemented with plaster of paris to the top of the pier.

The observations with pendulum No. 2 were unsatisfactory and were discarded.

Latitude $-34° 59' 20''$, longitude $173° 29'$ E, elevation 7^m. The time observations were made similar to the ones at Suva; and the chronometers were also kept in the artificial-line cabinet and the comparisons made thrice daily on the chronograph.

Although in the interval of five months and transport from Fiji, the Bond chronometer had materially changed its daily rate, from $-1^s{\cdot}60$ to $-10^s{\cdot}42$, yet the daily rate at either place was fairly uniform, so that the rate of the Dent is referred to the Bond by means of the differential rates from chronograph comparisons.

Date.	Dent. 48419.	Bond. 516.	D.—B.	Diff. corrected for Bond rate.	Dent. At time.	Dent. Daily rate.	Middle time of pend. swing.	Dent daily rate during swing.	Swing No.
1903.	h. m. s.	h. m. s.	s.	s.	h. m.	s.	h. m.	s.	
Dec. 16.....	2 56 00	2 56 04·00	... .	....					
" 21. ...	1 09 00	1 09 57·24	−57·24	. . .					
					13 05	− ·04	23 49	−3·48	1
" 22.....	1 01 00	1 02 07·56	−67·56	−67 60					
					3 05	−4·53	....	....	....
" 22.....	5 09 00	5 10 08·57	−68·57	−69·35			8 07	−2·83	2
					13 26	−1·03	16 37	−1·59	3
" 23.....	21 44 00	21 45 15·06	−75·06	−75·77					
					23 30	−2 80			
" 23....	1 15 00	1 16 16·18	−76·18	−76·59			0 29	−2·63	4
					8 26	−1·29	8 36	−1·22	5
" 24.. ..	15 36 00	15 37 21·64	−81·64	−82 41					
					19 46	+1·90	16 42	+1·04	6
" 24.....	23 57 00	23 58 25·92	−85·92	−85·26					

Northwest River.—This station was primarily occupied to observe the total eclipse of the sun on August 30, 1905. Professor L. B. Stewart, of the School of Practical Science, Toronto, was entrusted with the selection of the site and the determination of time and geographical positions, besides making gravity observations with the half-seconds pendulum apparatus used at the preceding stations. Professor Stewart writes: 'A small wooden structure 8 feet by 10 feet was speedily erected to serve as an observatory, having a transit slit in the roof closed by a trap door. Two concrete piers were also built, one in the middle of the building to serve as a support for the (10-inch) theodolite, and the other, a lower one, in the northeast corner for the pendulum receiver. * * * * Latitude was determined by observing the meridian altitude of stars' north and south. Moon culminations were observed for longitude. Time was determined by observing the transit of stars over the five threads of the theodolite, $12^s{\cdot}7$ intervals, clamp east and clamp west, recording the same on a chronograph. Dent sidereal chronometer No. 49,950 was used, as also for the pendulum observations. There were besides in the outfit sidereal chronometers Bond 516 and Dent 2,071, also mean time Bond 511.

The following are the results of the time observations for Dent 49,950 as given by Prof. Stewart.

Date.	Time.	Correction.	Interval.	Rate.
1905.	h. m. s.	s.	d.	s.
August 18	20 00 00	+25 74		
			2·9583	+1·30
" 21	19 00 60	+29·60		
			4·9653	+1·96
" 26	18 10 10	+39·35		
			4·3958	+3·24
" 31	3 40 00	+53·59		

The pendulum observations were reduced as the preceding, to infinitely small arc; temperature 15° C; and pressure 60^{mm}. There was no observation for flexure, and hence no correction. The apparatus having been mounted on a solid concrete pier the flexure correction would be confined to the units of the seventh decimal of a second in the period.

For each pendulum, direct and reversed, twelve coincidences were noted, giving thereby between the 1st and 11th, 2nd and 12th the interval for ten coincidences, from which the uncorrected period is obtained.

PENDULUM OBSERVATIONS AND REDUCTIONS.

Station—Montreal, Physics Building, McGill University.

Observer—OTTO KLOTZ.

Date.	Swing Number.	Pendulum	Position.	Knife-edge.	COINCIDENCE INTERVAL.	ARC.		Temperature.	Pressure.	PERIOD UNCORRECTED.	CORRECTIONS (7TH DECIMAL PLACE).					PERIOD CORRECTED.
					CHRONOMETER. / Standard Observatory sidereal clock.	Initial.	Final.			CHRONOMETER. / Observatory clock.	Arc.	Temperature.	Pressure.	RATE Observatory clock.	Flexure.	CHRONOMETER. / Observatory clock.
1902.					s.			C.	mm.	s.						s.
Sept. 10..	1	1	D	I	188·282	56′	19′	17°.73	47·5	·5013313	— 9	—114	+13	—230	—5	·5012968
" 11..	2	1	R	I	188·125	64′	24′	17° 49	49·5	·5013324	—12	—104	+11	—229	—5	·5012985
" 11..	3	2	D	II	169·828	67′	24′	17°.63	49·2	·5014764	—13	—110	+11	—228	—5	·5014419
" 11..	4	2	R	II	170·208	58′	20′	17°.63	51·8	·5014731	— 9	—110	+ 8	—228	—5	·5014387
" 12..	5	3	D	II	173·145	58′	21′	17°.63	48·8	·5014481	—10	—110	+11	—227	—5	·5014140
" 12..	6	3	R	II	173·120	55′	19′	17°.70	48·1	·5014483	— 8	—113	+12	—226	—5	·5014143

Mean pendulum.............................. ·5013840
Mean pendulum at Washington............... ·5015221

PENDULUM OBSERVATIONS AND REDUCTIONS.

Station Toronto, School of Practical Science. Observer—Otto Klotz.

Date.	Swing Number.	Pendulum.	Position.	Knife-edge.	Coincidence Interval. Dent Chronometers. No. 49950	No. 48419	Arc. Initial.	Final.	Temperature.	Pressure.	Period Uncorrected. Dent Chronometers. No. 49950	No. 48419	Corrections (7th Decimal Place). Arc.	Temperature.	Pressure.	Rate. 49950	48419	Flexure.	Period Corrected. Dent Chronometers No 49950	No. 48419	Mean.
1902.					s.	s.			C.	mm.	s.	s.							s.	s.	s.
Sept. 17..	1	1	D	I	181·154	179·816	59′	20′	17°·20	52·6	·5013839	·5013942	— 9	—92	+ 7	—232	—346	—5	·5013508	·5013497	·5013503
" 18..	2	1	R	I	181·709	179·939	58′	20′	17°.15	50·4	·5013796	·5013932	— 9	—90	+10	—231	—345	—5	·5013471	·5013493	·5013482
" 18..	3	2	D	II	164·131	162·353	58′	10′	17°·20	48·3	·5015278	·5015446	— 6	—92	+12	—229	—399	—5	·5014958	·5014956	·5014957
" 18..	4	2	R	II	164·422	163·024	58′	19′	17°.13	49·8	·5015251	·5015382	— 9	—89	+10	—228	—366	—5	·5014930	·5014923	·5014927
" 19..	5	3	D	II	167·320	165·657	58′	21′	17°.13	50·6	·5014986	·5015137	—10	—89	+ 9	—226	—374	—5	·5014665	·5014668	·5014667
" 19..	6	3	R	II	167·590	165·789	58′	19′	17°.25	47·0	·5014962	·5015125	— 9	—94	+13	—225	—382	—5	·5014642	·5014648	·5014645

Mean pendulum.................................... ·5014364
Mean pendulum at Washington.......................... ·5015221

PENDULUM OBSERVATIONS AND REDUCTIONS.

Station—Suva, Fiji. Observer—Otto Klotz.

Date.	Swing Number.	Pendulum.	Position.	Knife-edge.	Coincidence Interval. Chronometer. No. 48419 Dent.	Coincidence Interval. Chronometer. No. 516 Bond.	Arc. Initial.	Arc. Final.	Thermometer temperature. Green No. 116.	Pressure.	Period Uncorrected. Chronometer. No. 48419 Dent.	Period Uncorrected. Chronometer. No. 516 Bond.	Corrections (7th decimal place). Arc.	Corrections. Temperature.	Corrections. Pressure.	Corrections. Rate. Dent.	Corrections. Rate. Bond.	Corrections. Flexure.	Period Corrected. Chronometer. No. 48419 Dent.	Period Corrected. Chronometer. No. 516 Bond.	Period Corrected. Mean.
1903.					s.	s.			C	mm.	s.	s.							s.	s.	s.
July 12	1	1	D	I	135·855	135·988	68′	29′	20°·6	43·25	·5018470	·5018452	—15	—234	+20	—111	—93	—6	·5018124	·5018124	·5018124
" 15	9	1	D	I	134·85	135·29	64′	22′	22°·275	52·6	·5018608	·5018547	—11	—306	+11	—146	—93	—6	·5018150	·5018142	·5018146
" 13	2	1	R	I	135·86	135·643	64′	22′	21°·65	47·75	·5018469	·5018499	—11	—279	+16	— 71	—93	—6	·5018118	·5018126	·5018122
" 15	10	1	R	I	135·63	135·811	77′	23′	21°·15	51·0	·5018501	·5018476	—15	—258	+13	—121	—93	—6	·5018114	·5018117	·5018116
" 13	3	2	D	II	125·283	125·216	64′	31	23°·75	43·0	·5020035	·5020046	—15	—368	+21	— 87	—93	—6	·5019580	·5019585	·5019583
" 14	7	2	D	II	126·520	126·110	61′	23′	21°·625	48·25	·5019838	·5019903	—11	—278	+15	— 28	—93	—6	·5019530	·5019530	·5019530
" 13	4	2	R	II	126·067	125·865	61′	23′	21°·975	44·75	·5019910	·5019941	—11	—293	+19	— 52	—93	—6	·5019567	·5019557	·5019562
" 15	8	2	R	II	126·624	126·010	66′	27′	21°·7	48·25	·5019822	·5019919	—13	—282	+15	— 41	—93	—6	·5019495	·5019540	·5019518
" 14	5	3	D	II	128·08	127·60	59′	17′	22°·05	51·75	·5019596	·5019670	— 9	—296	+12	— 23	—93	—6	·5019274	·5019278	·5019276
" 16	11	3	D	II	127·513	127·50	70′	29′	21°·3	50·5	·5019683	·5019685	—15	—265	+13	— 91	—93	—6	·5019319	·5019319	·5019319
" 14	6	3	R	II	127·137	126·938	70′	20′	22°·95	54·0	·5019741	·5019772	—12	—334	+10	— 60	—93	—6	·5019339	·5019337	·5019338
" 16	12	3	R	II	126·96	127·486	77′	26′	21°·3	49·5	·5019769	·5019687	—16	—265	+14	—175	—93	—6	·5019321	·5019321	·5019321

Mean pendulum . . . . ·5018996

Mean pendulum at Washington. ·5015221

PENDULUM OBSERVATIONS AND REDUCTIONS.

Station—Doubtless Bay, N.Z. Observer—Otto Klotz.

Date.	Swing Number.	Pendulum.	Position.	Knife-edge.	Coincidence Interval. Chronometer. No. 516 Bond.	Coincidence Interval. Chronometer. No. 48419 Dent.	Arc. Initial.	Arc. Final.	Thermometer temperature. Green No. 118.	Pressure.	Period Uncorrected. Chronometer. No. 516 Bond.	Period Uncorrected. Chronometer. No. 48419 Dent.	Corrections (7th Decimal Place). Arc.	Corrections. Temperature.	Corrections. Pressure.	Corrections. Rate. Bond.	Corrections. Rate. Dent.	Corrections. Flexure.	Period Corrected. Chronometer. No. 516 Bond.	Period Corrected. Chronometer. No. 48419 Dent.	Period Corrected. Mean.
1903.					s.	s.			°	mm.	s.	s.							s.	s.	s.
Dec. 22..	1	1	D	I	157·02	161·48	73′	27′	21°·9	60·75	·5015972	·5015530	—16	—290	+ 4	—605	—202	—5	·5015060	·5015021	·5015042
" 22..	2	1	R	I	157·04	162·16	92′	31′	20°·65	55·25	·5015971	·5015464	—23	—237	+ 9	—605	—164	—5	·5015110	·5015044	·5015077
" 23..	5	3	D	II	147·49	152·46	68′	23′	20°·4	52·25	·5017008	·5016452	—12	—227	+12	—605	— 71	—5	·5016171	·5016149	·5016160
" 24..	6	3	R	II	146·71	152·82	67′	23′	20°·35	57 0	·5017098	·5016413	—12	—225	+ 7	—605	+ 60	—5	·5016258	·5016238	·5016248

Mean pendulum, I, III .... ·5015631
Mean pendulum, I, III, at Washington .... ·5014933

PENDULUM OBSERVATIONS AND REDUCTIONS.

Station—Northwest River. Observer—L. B. Stewart.

Date.	Swing Number.	Pendulum.	Position.	Knife-edge.	Coincidence Interval. Chronometer. No. 49950 Dent.	Arc. Initial.	Arc. Final.	Temperature.	Pressure.	Period Uncorrected. Chronometer. No. 49950 Dent.	Corrections (7th decimal place). Arc.	Corrections. Temperature.	Corrections. Pressure.	Corrections. Rate. Dent.	Period Corrected. Chronometer. No. 49950 Dent.
1905.					s.				mm.	s.					s.
Aug. 29..	1	1	D	....	231·0	93′·8	77′·6	9°·3	92·5	·5010846	—48	+238	—30	+171	·5011180
" 29..	2	1	R	....	231·8	81′·0	70′·6	9°·6	99·0	·5010808	—38	+226	—36	+174	·5011134
" 29..	3	2	D	....	203·2	86′·8	75′·2	9°·4	97·0	·5012333	—43	+234	—34	+174	·5012664
" 30.	4	2	R	....	203·5	89′·1	78′·7	9°·7	98·0	·5012315	—47	+222	—35	+177	·5012632
" 30..	5	3	D	....	205·4	85′·7	77′·6	14°·23	99·2	·5012201	—44	+32	—31	+180	·5012335
" 30.	6	3	R	....	205·3	86′·8	77′·6	14°·90	98·2	·5012207	—45	+4	—33	+180	·5012313

Mean pendulum .... ·5012043
Mean pendulum at Washington .... ·5015221

In the following abstract the computed g_c has been obtained from Helmert's formula (5).

$$g_c = 978 \cdot 046\ (1 + \cdot 005302\ \text{Sin}^2\ \phi - \cdot 000007\ \text{Sin}^2\ 2\ \phi)$$

The observed g_o is obtained from the observed periods compared with that at Washington, $g_o = \frac{P^2_w\, g_w}{P^2_o}$, g_w being taken at 980·098 dynes.

Station.	Difference from Mean Pendulum in 7th decimal.		
	No. 1.	No. 2.	No. 3.
Washington, 1	+880	−570	−309
2	+888	−578	−308
Ottawa, 1	+879	−578	−321
2	+883	−576	−289
Montreal, 1	+864	−563	−301
Toronto, 1	+872	−578	−292
Suva, 1	+873	−575	−311
2	+865	−528	−324
Northwest River, 1	+886	−605	−281
Mean	+877	−572	−304

Station.	Latitude.	Longitude.	Elevation.	Computed g_c.	Observed g_o.	$g_o - g_c$
Washington	38° 53′ 13″	77° 01′	10m	980·083	980·098	+·015
Ottawa	45 25 23	75 42	73	980·670	980·593	−·077
Montreal	45 39 22	73 34	40	980·678	980·638	−·040
Toronto	43 39 35	79 24	106	980·511	980·433	−·078
Suva	−18 08 45	178 26 E	2	978·547	978·624	+·077
Doubtless Bay	−34 59 20	173 29 E	7	979·745	979·825	+·080
Northwest River	53 31 31	60 10	2	981·393	981·341	−·052

SEISMOLOGY.

The last quarter of a century stands out pre-eminently as the most marked in seismic disturbances of which we have any historic record. It began with that cataclysmic explosion of Krakatoa in 1883, noted for the red sun-sets that followed for the next two years, due to the suspended dust in the upper regions of the atmosphere. Of the more important disturbances we may mention those of Ischia near Naples; Charleston, South Carolina; Tarawera, New Zealand; the calamitous Mino-Owari earthquake in 1891, in Japan, when more than 20,000 lives were lost; Saint Pierre in the West Indies; Formosa; Vesuvius; the Alaska upheavel in 1899; the great Indian earthquake at Kangra in 1905 which cost close on 20,000 lives; and the recent destructive quakes at San Francisco, Valparaiso, Kingston (Jamaica) and Chilpancingo (Mexico). It is estimated that the total loss of life from these disturbances is at least 150,000.

The great Mino-Owari earthquake was the immediate reason for the birth of the Earthquake Investigation Committee, which has since then contributed so much by its 'Publications' to the study of earthquakes. Five years later the British Association for the Advancement of Science, through the indefatigable labours of the eminent seismologist, Professor John Milne, formed a Seismological committee; and now through the destructive earthquake in San Francisco the American Association for the Advancement of Science has formed a committee on Seismology of 15 members, of whom the writer is one.

Some of the objects in view in forming the Committee on Seismology in America are as follows:—

1. To be available for, and to initiate counsel in connection with legislation which provides for investigations of earthquakes or the means of investigating their dangers.

2. To bring into harmony all American and Canadian institutions doing seismological work, and to guard against unnecessary duplication of studies.

3. To organize, if thought best, a correlated system of earthquake stations, which should include the outlying possessions and protectorates.

4. To advise regarding the best type or types of seismometers for the correlated stations.

5. To disseminate information regarding construction suited to earthquake districts.

6. To collect data regarding the light as well as the heavy shocks, and to put the results upon record.

7. To start investigations upon large problems of seismology.

8. To advise with some weight of authority where catastrophic earthquakes have wrought national calamity.

Since its appointment the Committee has held one meeting and amongst the important resolutions may be mentioned, 'that the time has come to ask the support of the federal government for seismological work.'

The scope of the committee will in course of time broaden and many questions not only of scientific but of immediate practical importance will be taken up. It will undoubtedly fall to the lot of this newer science of seismology to answer unsolved questions in astronomy, geodesy, geology and meteorology pertaining to the physics of the earth. The field is large, but most promising for cultivation.

The most important organization for the study of seismology is the 'International Seismological Association,' which will hold its second conference next September at the Hague.

Practically every civilized country in the world has joined the association and appointed a representative for the quadrennial meetings, showing that the study of seismology is not confined to countries that are notably subject to more or less destructive earthquakes, but the subject is recognized as one of grave importance and for its full development and evaluation, co-operation is necessary. The more widely stations are distributed over the world and records obtained, the more readily will the true nature of earthquake waves with the accompanying phenomena producing them, be determined. Although the study is that of earthquakes, yet it involves and embraces much besides, which is of the greatest interest to all countries, irrespective of their susceptibility to quakes or not.

In the pursuit of knowledge for the amelioration of mankind, science knows neither political nor geographical boundaries.

The seismograph at Ottawa has been in continuous operation, with slight interruptions due to repair of the clock work of the registering apparatus, and the study of the instrument and seismograms have received considerable attention.

An investigation has been begun with reference to the behaviour of the horizontal pendulum, when compared with the fluctuation of pressure on the earth's surface due to barometric changes. This is a very involved problem, for results obtained for a given change of atmospheric pressure at one place does not necessarily produce the same effect upon a similarly sensitive pendulum at another place, for the reason that the coefficient of elasticity of the immediate earth's crust may be not the same for the two places. The series is not as yet sufficiently extended to enable definite conclusions to be drawn.

The method of investigation may be briefly outlined. Every morning during the interval of taking off and putting on a fresh sheet the position of the images of the two pendulum mirrors is taken by means of a millimetre scale, read to tenths, and referred to the south solid brick wall of the seismograph room, and immediately opposite the slit of the registering apparatus. That is, the position and change of the zero point are daily measured. This is in the first place, on the supposition that the change is due to the tilting of the pier. The angular movement of the wall from which the measurements are made is subject of course to the same movement as the pier from bending of the earth's crust, and therefore shows no relative displacement, whatever the bending. However as the image is magnified 120 times, and its movement is confined to individual millimetres, the movement of the wall in comparison with it is evanescent.

These movements in linear measure are then converted into arc by the formula

$$\beta = \frac{\pi^2 D}{2\, n\, g\, t^2 \operatorname{Sin} 1''}$$

where $t =$ period of pendulum (one-half complete vibration).
$g =$ gravity.
$D =$ linear displacement.
$2\,n =$ magnification.

Assigning values in the above we find $\beta = ''{\cdot}2122\ D$.

Estimating measurements to tenths of a millimetre, it will be seen then an inclination of about one-fiftieth of a second of arc can be read, which is equivalent to a grade of one foot in 2,000 miles.

We obtain therefore the apparent tilting in the planes normal respectively to the two pendulums, i.e., in the meridian and in the prime vertical, and by composition the resultant of the two, that is, the actual direction as well as the magnitude of tilting.

From the daily weather maps issued by the Meteorological service, Toronto, are obtained the isobars, or lines of equal barometric pressure, drawn at intervals of one-tenth inch difference of pressure. For our immediate purpose the two isobars between which Ottawa falls, are examined in order to obtain the pressure gradient and direction, the latter being normal to the two isobars. The closer the isobars are together, the steeper will be the gradient and the greater will be the apparent tilting of the pier, being in the direction of the normal to the two isobars which passes through Ottawa. The pier will tend to incline from an area of 'low' barometer to the area of 'high' barometer. It may be remarked that a difference of pressure of one millimetre is equivalent to a load of 13,600,000 kg. on a square kilometre, and that a change of 15 millimetres within the 24 hours has on more than one occasion been experienced here. This latter change of pressure is equivalent to 600,000 tons per square mile. By the investigations of Professor (now Sir) G. H. Darwin* 'On variations in the vertical due to elasticity of the earth's surface,' some very interesting results were obtained with reference to the amount of distortion to which the upper strata of the earth's mass are subjected, when a wave of barometric depression or elevation passes over the surface. He showed a very remarkable relation to exist between the slope of the surface of an elastic horizontal plane and the deflection of the plumb-line caused by the direct attraction of the weight producing the slope, and this relation is expressed by the ratio $\frac{v}{g}$ to $\frac{1}{3}\, a\, \delta$ in which g is gravity, v is modulus of rigidity, a is the earth's radius, and δ is the earth's mean density. 'This ratio is

* Philosophical Magazine, vol. 14, Fifth series, p. 409.

independent of the wave-length of the undulating surface, of the position of the origin, and of the azimuth in the plane of the line normal to the ridges and valleys. Therefore the relation is true of any combination whatever of harmonic undulations; and as any inequalities may be built up of harmonic undulations, it is generally true of inequalities of any shape whatever.'

If we take the barometric range at five centimetres, about two inches, we have a difference of pressure on every square yard of nearly 1,300 pounds, or over half a ton. Darwin in order to obtain a numerical value for his deduced equations for slope and attraction assumed the rocks as one-quarter as stiff again as the stiffest glass, that is, the rigidity of glass in gravitation units as 3×10^8, for the range of pressure 2·5 centimetres on each side of the mean. With this assumption he finds the minimum apparent deflection of the plumb-line, consequent on the elastic compression of the earth to amount to ″·0117, and this is augmented to ″·0146 when the true deflection due to the attraction of the air is added. So that the whole range of the deflection between high pressure and low pressure would be ″·0292; and furthermore, that the ground is nine centimetres higher under the barometric depression than under the elevation, that is when the barometer is very high we are at least three inches nearer the earth's centre than when it is very low.

Darwin concludes his article, 'If barometric pressure, tidal pressure, and the direct action of the sun and moon combined together to make apparent slope in one direction, then, at an observatory remote from the sea-shore, that slope might perhaps amount to a quarter of a second of arc. . . . . I venture to predict that at some future time practical astronomers will no longer be content to eliminate variations of level merely by taking means of results, but will regard corrections derived from a special instrument as necessary to each astronomical observation.'

It has been shown that with the present adjustment of the instrument, and it is near its limit of sensitiveness the smallest reading that can be made with any degree of certainty is ″·0212 which is but slightly less than Darwin's maximum value.

As Darwin's assumed values can suffer but little change, it will be seen that the investigation presents great difficulty for showing clearly the relationship between barometric gradients and oscillations of the pendulum zero, for other factors are involved too. However, the series of observations when sufficiently extended will undoubtedly disclose the cause of the fluctuation or deviation from the vertical.

In tabulating the occurrence of earthquakes during the various months of the year it is found that there is a marked predominance for the colder season of the year. Long observations and investigations have established a relationship between earthquakes and atmospheric conditions, not, however, in the sense in which it was held by the ancients, that is, that earthquakes produced meteorological phenomena, such as storm, hail, rain, cold, heat—in fact the whole gamut of weather. The relationship is, however, just the reverse of that attributed by the old philosophers. The predominance that has been found for the colder season is not attributable, however, to atmospheric temperature, this is a mere co-incidence, but during that period of the year the barometric gradients are in general greater than at other times, and thereby in a secondary manner act as 'the last straw to break the camel's back.' That is, as stresses are ever existant in the crust of the earth, increasing towards the limit of elasticity or resistance, the differential loading of the surface of the earth into those areas subject to quakes and which are intersected by regional geological faults or planes of weakness, may set the fuse to bring about the downfall, or adjustment to temporary equilibrium,—an earthquake takes place.

Although the stress produced by atmospheric loading is very small compared with the tectonic stresses set up within the crust by other causes, it is evident that if a steep barometric gradient passes over a line or plane of weakness in a part of the crust under great tension or stress approaching rupture, that the rupture will be accelerated by such atmospheric conditions.

In a great earthquake if the surface shows no marked manifestations of rifts, of torn ground, it seems to indicate that the hypocentre was very deep beneath the surface. The various influences that may be considered as affecting the vertical or the slow movement of the pendulum are atmospheric pressure; atmospheric attraction; deformation of the surface by lunar and solar attractions; direct effect of lunar and solar attractions; deformation of the surface by solar radiation and by constant tectonic movements or strains; change of temperature of the apparatus; and irregular strains in the pier itself. As will be seen, some of these influences are periodic. The maximum horizontal force due to the moon deflects the vertical ″·0174, and that due to the sun ″·0074. The effective force varies with the zenith distance and azimuth of the attracting body, and as the two pendulums are mounted respectively in the meridian and prime vertical each requires its own reduction for eliminating the effect of the disturbing influences. Ehlert records* a change of level for the horizontal pendulum of 27″ during three and one-half days, this being an abnormal fluctuation. For the month May 10—June 10, 1907, the horizontal pendulum here showed a mean daily change of the vertical of 0″·36 and 0″·34, the former for the E.—W. pendulum and the latter for the N.—S. one. Ehlert found from observations at Strassburg that the mean diurnal fluctuation of the ground due to the heat of the sun expanding the surface of the earth, the hemisphere turned towards the sun suffering ellipsoidal distortion amounted to ″·112, being of course greater in summer (″·208) with clearer sky and longer sunshine than in winter (″·016). As the pendulum pier at Strassburg is 5 metres beneath the surface, A. Schmidt, quoted by Sieberg,‡ has raised doubts about the above values, maintaining that the daily variation of temperature is confined to about 1 metre depth of soil, and certainly does not extend to a depth of 5 metres. The pendulum pier here is at a depth of 3 metres beneath the surface of the soil. E. V. Reubur-Paschwitz noted at Wilhelmshaven† a marked movement of the pendulum synchronizing with the varying height of the barometer. It corresponded to a deviation of the vertical of ″·29 for a change of 1 millimetre in the height of the barometer. This extraordinary fluctuation was attributed to the marshy spongy nature of the environment.

The later and extended observations of v. Paschwitz at Strassburg make the deflection of the effect of barometric pressure on the pendulums there uncertain. It undoubtedly exists, it is a question of measurement and subsequent elimination of the other disturbing influences.

It is found that about 1 p.m. throughout the year the periodic deviation of the pendulum is practically zero,§ so that readings at this time are best adapted for the determination of the irregular movements. During a period of ten and a half months the Strassburg || pendulum slowly moved from +12″ to − 130″ or a total of 142″. During the same period the change of nadir was only 25″. The curve for the latter followed closely that of the temperature of the cellar while the curve for the pendulum does not synchronize with that for temperature. The relative humidity of the basement does not appear to influence the pendulum.

In the accompanying table I, is shown the daily movement of each pendulum and the deduced apparent tilting of the pier in magnitude and direction since the beginning of the investigation. Plates 1 and 2 show graphically this movement. Plate 3 shows the relative humidity, which is markedly higher during that part of the year when the basement and building are not artificially heated.

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* Beiträge Zur Geophysik IV. p. 70.
† Beiträge Zur Geophysik II., p. 334.
‡ Handbuch der Erdbebenkunde p. 197.
§ Beiträge Zur Geophysik II. p. 329.
|| Ibid p. 318.

TABLE I.

DAILY CHANGE OF PENDULUM ZERO.

S = + N = −
W = + E = −

Date.	Change β N—S component.	Change β E—W component.	Change β Apparent tilting of pier	Date.	Change β N—S component.	Change β E—W component.	Change β Apparent tilting of pier
1907.	"	"	"	1907.	"	"	"
Mar. 7-8..	+ ·21	+ ·21	SW ·30	May 3-4..	— ·30	— ·36	NE ·47
" 8-9.	+ ·53	+ ·32	SW ·62	" 4-5.	— ·11	— ·11	NE ·15
" 9-11..	+ ·53	+ ·11	SW ·54	" 5-6..	— ·32	+ ·51	NW ·60
" 11-13..	— 1·06	+ ·21	NW 1·08	" 6-7..	— ·30	— ·19	NE ·35
" 13-14..	— ·74	+ ·64	NW ·98	" 7-8..	+ ·49	— ·23	SE ·54
" 14-15..	— ·95	+ ·85	NW 1·27	" 8-9..	— ·57	— ·08	NE ·58
" 15-16..	— ·21	+ ·74	NW ·77	" 9-10..	— ·81	— ·38	NE ·89
" 16-18..	— 3·92	·00	N 3·92	" 10-11..	+ ·85	+ ·49	SW ·98
" 18-19..	— ·39	+ 1·70	NW 1·74	" 11-12.	— ·25	+ ·13	NW ·28
" 19-20..	— ·04	+ ·48	NW ·48	" 12-13..	— ·51	+ ·55	NW ·75
" 20-21..	— ·53	— 1·59	NE 1·67	" 13-14..	+ ·46	— ·97	SE 1·07
" 21-22..	— ·53	+ 2·44	NW 2·49	" 14-15..	+ ·06	— ·36	SE ·36
" 22-23.	— ·48	+ ·74	NW ·88	" 15-16..	+ ·34	— ·60	SE ·69
" 23-25..	— 1·64	+ 1·59	NW 2·28	" 16-17..	— ·51	— ·38	NE ·63
" 25-26..	— 1·33	+ ·57	NW 1·45	" 17-18..	— ·68	— ·38	NE ·71
" 26-27..	— 1·35	+ ·80	NW 1·57	" 18-19..	— ·04	— ·08	NE ·09
" 27-28..	— 23	— ·57	NE ·61	" 19-20..	— ·15	— ·06	NE ·16
" 28-29..	— ·42	+ 1·00	NW 1·08	" 20-21..	— 1·21	— ·30	NE 1·25
" 29-30..	— ·87	+ ·17	NW ·88	" 21-22..	+ ·91	— ·08	SE ·91
" 30-31..	— 08	+ 1·19	NW 1·19	" 22-23..	+ ·11	— ·19	SE ·22
" 31-1..	— ·21	+ ·55	NW ·59	" 23-24.	— ·06	— ·28	NE ·29
April 1-2..	— ·99	+ ·66	NW 1·19	" 24-25..	— ·57	·00	N ·57
" 2-3..	— ·32	+ ·57	NW ·65	" 25-26..	— ·28	·00	N ·28
" 3-4..	— ·21	+ ·13	NW ·25	" 26-27..	— ·30	— ·40	NE ·50
" 4-5.	+ ·34	+ ·34	SW ·48	" 27-28..	+ ·25	— 1·76	SE 1·78
" 5-6..	+ ·64	+ ·68	SW ·93	" 28-29..	— 44	— ·11	NE ·45
" 6-7..	+ ·21	+ ·95	SW ·97	" 29-30.	+ ·62	— ·17	SE ·64
" 7-8..	— ·89	— ·15	NE ·90	" 30-31..	+ ·34	— ·36	SE ·49
" 8-9.	+ ·29	+ ·34	SW ·45	" 31-1.	— ·15	— ·40	NE ·43
" 9-10..	— 1·14	— 1·04	NE 1·54	June 1-2..	— ·32	— ·30	SE ·44
" 10-11..	·00	+ ·19	W ·19	" 2-3.	— ·40	·00	N ·40
" 11-12..	+ 1·02	+ 1·76	SW 2·03	" 3-4..	— ·36	— ·19	NE ·41
" 12-13.	— ·02	+ ·44	NW ·44	" 4-5..	— ·08	— ·21	NE ·22
" 13-14..	— ·68	+ ·06	NW ·68	" 5-6..	·57	— ·89	NE 1·05
" 14-15..	— ·60	+ ·42	NW 73	" 6-7..	— ·62	— ·02	NE ·62
" 15-16..	— ·87	+ ·25	NW ·90	" 7-8.	— ·06	— ·19	NE ·20
" 16-17..	— ·25	+ ·17	NW ·30	" 8-9..	— ·08	— ·11	NE ·14
" 17-18.	— ·51	+ ·28	NW ·58	" 9-10..	— ·49	— ·53	NE ·72
" 18-19..	— ·44	+ ·83	NW ·94	" 10-11..	+ ·23	— ·02	SE ·23
" 19-20	— ·60	+ ·64	NW ·88	" 11-12.	— ·17	— ·51	NE ·53
" 20-21..	....	....	....	" 12-13..	+ ·13	+ ·30	SW ·33
" 21-22..	....	....	....	" 13-14..	+ ·19	— ·70	SE ·73
" 22-23..	....	....	....	" 14-15..	+ ·23	·38	SE ·45
" 23-24..	— ·04	— ·11	NE ·12	" 15-16..	— ·02	— ·62	NE ·62
" 24-25.	— ·15	— ·23	NE ·27	" 16-17.	— ·55	— ·17	NE ·57
" 25-26..	— 15	— ·36	NE ·39	" 17-18..	— ·55	— 1·66	NE 1·75
" 26-27..	— ·62	+ ·06	NW ·62	" 18-19..	+ ·17	+ 1·38	SW 1·39
" 27-28..	— ·28	— 34	NE ·44	" 19-20..	— ·25	— ·30	NW ·39
" 28-29..	+ ·34	— ·36	SE ·49	" 20-21..	— ·34	— ·02	SE ·34
" 29-30.	— ·19	— ·53	NE ·56	" 21-22..	+ ·06	+ ·08	SW ·10
" 30-2..	— ·19	+ ·15	SW ·24	" 22-23..	— ·32	·70	NE ·77
May 2-3..	— ·08	·25	NW 26	" 23-24..	— ·55	— ·11	NE ·56

The atmospheric pressure over a portion of the surface of the earth may be represented as a meniscus resting on the earth and whose dimensions are determined by the isobars. This meniscus or cap with ever varying form slides over the earth like a heavy weight, deforming the surface. If we imagine the surface studded with vertical rods, these, as the meniscus moves along, will always be inclined towards the summit of the cap. For our geographical position the path of the meniscus is from the northwest and thence down the valley of the St. Lawrence, so that we must expect to find the prepondering swaying at Ottawa to be in our east-west direction, and manifested more by the north-south pendulum than by the one in the prime vertical.

Beside these slow movements of the pendulums that have been considered there are others, spoken of as microseismic to distinguish from the macroseimic or those from actual earthquakes. It appears that pulsations are set up in the earth, just how is not yet clearly established, and these are communicated to the pendulum. Were it possible to disentangle the movement of the pendulum itself, the pulsations of the earth would be much simplified. The pendulum for no length of time remains a steady point, but instead is set oscillating by the pulsations. The period of the pulsations may be very long, 200^s, but generally is very much less. The pendulum is the more readily set in vibration when the period of the oscillation corresponds to or is a multiple of the period of the pendulum. Professor Milne concludes from his observations that the oscillations may be and are in certain cases produced by steep barometric gradients and by winds. A very satisfactory proof of this is our barograph record and the seismogram of June 18, last. At 3.50 p.m. on that day the barograph rose abruptly from 755^{mm} to $756{\cdot}2^{mm}$ only to drop again to its former reading, repeating this zigzag movement during fully four hours, recording five maxima, and five minima with a difference of about a millimetre in that interval. It may be remarked that a high 'gusty' wind was noted that afternoon before the records of the barograph or seismograph were known. Apparently at the same moment, as closely as one can read the time scale on the barograms, both pendulums—the E—W one particularly—began recording earth tremors in pulsations. The displacement of the pendulum as shown in the seismogram was fully a millimetre (magnification 120), but the line traced was very irregular, and was in keeping with the 'puffy,' 'gusty' wind and the jerky behaviour of the barograph. The bottom of the pier, resting on boulder clay and supporting the seismograph, is very nearly 3 metres beneath the outside surface, so that the wind was very effective at this depth. Dependent upon the nature of the soil, it has been found for sandy ground that even at a depth of 25^m, the wind-effect was reduced only one-half of that for the immediate surface. In the case cited above for June 18, the seismogram was undoubtedly a direct and almost instantaneous response to the fitful barometric gradient and its concomitant wind, and the pendulums were not set swinging, responding to vibrations set up in the earth's crust by friction of a steady wind as is maintained by some as necessary. Oscillations produced by this latter means would undoubtedly show rhythm which is absent in our case.

Then we have oscillations set up by internal stresses. They come and go quite independent of atmospheric conditions or cosmic influences. The pulsations and records are generally the most uniform seismograms obtained. They may last for a short time, or for hours or days. Earth tremors or oscillatory pulsations as interpreted on our seismograms appear to be fitful impulses, which set the pendulums swinging *uniformly* for a minute or so, with an amplitude of less than a millimetre (120 magnification), then the oscillation dies down, interference is noticed changing the uniformly serrated record, to be followed again by half a dozen or more uniform swings. It will be hence noted that in these earth pulsations the pendulum does not act as a steady point at all. When we come to look at the record for a macroseism or earthquake, the apparent behaviour of the pendulum is different. Beginning with the 'preliminary tremor' the pendulum bob apparently does not respond to the movements of the earth but acts as a 'steady point' or fairly so; when, however, we come to the principal portion with the more or less violent oscillations we find practically the period to be that of the pendulum with occasional or frequent interference phenomena, by which the pendulum is momentarily stopped and the direction of swing at the time reversed.

It must be borne in mind that the period of the pendulum is about $5{\cdot}7^s$, and as that value is near that of predominating periods of earthquake waves, there is difficulty in separating or distinguishing the two on the seismograms. With the earth pulsations or microseisms we have a more or less continuous adjustment towards equilibrium, until the earth settles down for a time to a quiescent state. Earth tremors may be looked upon, however, as a manifestation of the normal condition of the earth's crust, which must necessarily be subject to strains and stresses. It is not to be expected that an instrument can be devised that will faithfully record only the movements of the earth particles and not the movements of the apparatus also.

On account of the small movement in the first preliminary tremors, the Bosch photographic seismograph, with light steady mass and high magnification, is well adapted to record them.

The hieroglyphics drawn by the seismograph have not yet been fully read; they await the finding of their Rosetta stone.

The earth tremors are frequently the precursors for hours of an earthquake, *e.g.*, that of San Francisco and of Mexico (April 15, 1907), at other times no disturbance is noticed until the earthquake shock arrives.

From a seismogram we may (not always) obtain the movement of the earth-particle, that is, its amplitude a, (half-range) and period t, then on the assumption of simple harmonic motion, we have for the maximum velocity $v = \frac{2\pi a}{t}$, and if $f =$ the maximum acceleration per second per second $f = \frac{v^2}{a} = \frac{4\pi^2 a}{t^2}$. The maximum acceleration is proportional directly to the amplitude and inversely to the square of the period. The amplitude is measured in millimetres and the time in seconds. For earth tremors a is a very small fraction of a millimetre and t generally more than 5 seconds, so that the value of v is less than a hundredth of a millimetre per second, for $a = \cdot 01^{mm}$ $t = 10^{s}$ and the maximum acceleration is correspondingly small, a thoroughly evanescent quantity as far as the effect on objects is concerned. Even the records of severe distant earthquakes show a very small acceleration, say a millimetre per second per second.

If V is the speed of propagation, and λ the length of the wave, then $\lambda = Vt$, t being the time of period of oscillation of the earth particle, which is the time interval also from crest to crest of the wave.

V the velocity of propagation is dependent upon the medium transmitting the oscillations—its co-efficient of elasticity and of rigidity.

The expression for V is, $V = \sqrt{\frac{E}{\rho}}$, where E is the elasticity of the medium and ρ its density. This applies to a longitudinal wave in a homogeneous medium.

To give an example for the latter, Adams* gives the value of E for plate-glass as $7 \cdot 24 \times 10^{11}$, and for diabase $9 \cdot 49 \times 10^{11}$ in C. G. S. units. Taking this latter value and the mean density as $2 \cdot 57$ we find $V = 6 \cdot 08^{km}$ per second or 365^{km} per minute which is about two-thirds of the velocity of the first preliminary tremors of the San Francisco earthquake of last year (April 18).

The elasticity required to give the observed velocity would hence be 22×10^{11}, which is the modulus for steel. If the density were increased we would obtain a still greater value for E.

Professor E. Oddone has deduced from some large quakes (Balkans, San Francisco, Valpariso) that the time of diametral passage through the earth of the first preliminary tremors, longitudinal waves, is $16 \cdot 5^{m}$. Then taking the mean density of the earth as $5 \cdot 6$ he obtains for E 85×10^{11} which indicates a rigidity 'quatre fois plus rigide que le fer, et sept fois circa plus rigide, que les plus rigide roches archaiques.'† We see therefore that the resistance to compression of the matter of the earth is far in excess of that of any known material of the surface of the earth. Although the direction of the path of the various vibrations is not accu-

* Elastic Constants of Rocks, p. 69.

† Quelques constantes sismiques trouvées par les macrosismes, p. 25

rately known, *i.e.*, whether the pulsations travel along chords, circular arcs or other curves, data necessary for getting accurate velocity determinations, nevertheless seismology has definitely settled the question of the nature of the interior of the earth as to solidity or otherwise. Not only has solidity been established, but also a fair measure of its rigidity.

Oddone draws attention to a curious coincidence between the time of propagation of a longitudinal wave along a diameter of the earth and the time of a light wave to cross the earth's orbit, each being approximately $16{\cdot}7^{\text{min.}}$

Oddone rounds off the figure to $17^{\text{m}} \pm 1^{\text{m}}$, and takes it as the constant for longitudinal waves through the earth. He designates it by the letter *P*, in honour of the President (Prof. Palazzo) of the International Seismological Association.

In a recent paper* by Professor A. E. H. Love on 'The Gravitational Stability of the Earth' he says: 'The elastic constants of the earth, in its present state, can be estimated from the observed velocities of propagation of the three types of waves which are transmitted when a great earthquake takes place. There are two sets of preliminary tremors propagated directly through the earth with nearly constant velocities of about 10 kilometres per second and 5 kilometres per second, and a main shock propagated over the surface with a velocity of about 3 kilometres per second. The two sets of tremors have been identified with waves of dilatation and distortion, and the main shock with superficial waves of the type first investigated by Lord Rayleigh. In the present paper reason is given for thinking that the manner of propagation is not much affected by gravitation and initial stress, and thus the observed values of the velocities of propagation of earthquake tremors and shocks would yield (1) for the seismic effective modulus of compression of the earth as a whole the value $36{\cdot}9 \times 10^{11}$ dynes per square centimetre; (2) for the seismic effective rigidity of the earth as a whole the value $13{\cdot}8 \times 10^{11}$ dynes per square centimetre; (3) for the seismic effective rigidity of surface rocks a value approximately equal to 6×10^{11} dynes per square centimetre.'

It is evident that seismograms contain the story, however involved, of the earth-wave; whence it came, its vicissitudes *en route*, passing through different media of different densities, being reflected and refracted, encountering in the upper part of the crust geological dislocations, faults and dikes, each having its effect upon the velocity, acceleration and destructive force. Professor A. E. H. Love in his presidential address recently before section A, British Association for the Advancement of Science, says: 'If we knew the distribution of density of the matter within the earth it would be a mathematical problem to determine the form of the geoid, *i.e.*, of the equipotential surface of the earth.' There is no doubt but that the seismogram bears a message on this subject. With the accumulation of seismograms from many and widely distributed stations and their collective study and analysis, there can be no doubt that the interior of the earth must yield up its secrets, and the seismologist will be able to furnish data of the greatest value for which scientists have hitherto groped in vain.

In the accompanying diagram, Plate IV., is shown the effect of air-damping on the amplitude of the oscillations. The record was obtained by giving each pendulum a slight tap with a lead pencil. It may be stated that a fresh electric candle (32 c.p.) was put into the lamp in order to obtain a good impression for the rapid motion of the light spot. The curve is exponential, and the ordinate is a function of the time.

The relationship between any two complete amplitudes is $\dfrac{y_.}{y_n} = f^n$, where f is the factor of diminution in amplitude for successive oscillations, *i.e.*, for equal increments of time, or the period of the pendulum comprising the two oscillations. f may be expressed as equal to e^k, where $e = 2{\cdot}71828$, the base of the Napierian or natural logarithms, and k is designated the logarithmic decrement.

* Proceedings Royal Society, vol. 79, p. 194

Taking linear measures from the (enlarged) diagram for values of y, we find f for the E-W pendulum to be 1·31, and hence k = ·27; while for the N-S pendulum the corresponding values are 1·22 and ·20. The damping in the small air-chambers, with the moveable sides, of the two pendulums was not quite the same.

If we put T^1 for observed period of the pendulum, and τ for the time in which the amplitude has decreased the e^{th} part, then evidently $f^2 = e^{\frac{T^1}{\tau}}$ or $\frac{T^1}{2\tau} = \text{nat. log } f$.

Taking linear measures again, and taking the mean value for independent determinations of τ, we obtain its value for the E-W pendulum to be $10{\cdot}6^s$, and for the N-S pendulum 14·5s.

This is the damping when the instrument was set up, but it is intended by some means to increase the same.

The following are the principal earthquakes recorded since the beginning of the year. Unfortunately the first one, that in January at Kingston, Jamaica, has no time scale, from failure of the relay which works the shutter. This was only noticed when the sheet was developed. The two following days, January 15 and 16, showed much unrest of the earth on the seismogram, especially on the latter day.

The next earthquake of consequence was that on the Pacific coast of Mexico, by which several towns were destroyed on the morning of April 15. The pulsations as shown on the seismogram were more intense than those for the destructive earthquake at Kingston.

The following is the record:—

	N-S Component.			E-W. Component.		
	h.	m.	s.	h.	m.	s.
First preliminary tremors began	1	15	04	1	15	03
Second preliminary tremors began	1	19	26	1	19	30
Principal portion began	1	27	20	1*		
Principal portion ended	1	43		1	43	
End of earthquake	3	01		3	09	

(The amplitudes gradually decreased into irregular wavy lines and merged into 'sawtooth' tremors, which lasted for some hours.)

Maximum amplitude	$14^{mm.}$	$14^{mm.}$
Period of pendulum	$5{\cdot}7^s$	$5{\cdot}7^s$
Magnification	120	120

The time scale is direct from the standard mean time clock, 75° meridian and requires no correction.

The following is the record of the earthquake in Ecuador on the morning of June 1, 1907:—

For hours before the quake was registered, the earth was in a state of unrest and the seismogram for both pendulums shows the characteristic regular 'sawtooth' pulsations, amplitude $\cdot 2^{mm}$ to $\cdot 3^{mm}$ (magnif. 120).

These tremors were replaced on the N-S component (E-W pendulum) by more or less irregular movements, amplitude 1^{mm}, beginning at $3^h\ 48^m\ 44^s$, while for the other pendulum the tremors continued, showing absolutely no movement corresponding to the preceding time, until $3^h\ 55^m\ 14^s$, when an abrupt movement, amplitude $2{\cdot}5^{mm}$, took place, the other pendulum showing a marked increase in amplitude, $1{\cdot}5^{mm}$, at $3^h\ 55^m\ 20^s$. The amplitudes thereafter for both decreased irregularly until at $3^h\ 58^m\ 56^s$, the N-S pendulum increased to $2{\cdot}5^{mm}$ and the other to $1{\cdot}5^{mm}$, which neither exceeded thereafter. The last large oscillations occurred for the E-W pendulum between $4^h\ 11^m$ and $4^h\ 12^m$, and for the N-S pendulum between $4^h\ 10^m$ and $4^h\ 11^m$. The quake continued till $4^h\ 30^m$ showing as an irregular wavy line, when the tremors similar to those preceding the quake manifested themselves for many hours.

* Photo record too faint.

As far as can be gathered from the press reports of the time, it appears that the epicentre was about due south of Ottawa. If the horizontal movement of the pier is in the plane of the great circle between the epicentre or hypocentre and here, then the preliminary tremors coming through the earth would not disturb the pier relative to the N-S pendulum, which records essentially an E-W motion, the pendulum would be hit end-on. On the other hand the E-W pendulum, giving N-S component would have its maximum effect.

Although it is considered that the seismogram reveals but little of the direction of the epicentre from the place of observation, giving instead the direction of the end or last part of the impulse, yet the above record would seem to show clearly that the first preliminary tremors, longitudinal waves, arrived in the direction of the epicentre from here. Furthermore it is to be noted that when the N-S pendulum did move, it did so abruptly and with an amplitude as large as was recorded during the whole quake. Such an abrupt movement required essentially an east and west oscillation of the earth particles, transverse waves in this case. This movement agrees too with the record of the E-W pendulum, whose amplitude for that time is only about one-half that of the other pendulum. The E-W pendulum recorded the quake for about 10 minutes longer than the N-S pendulum did (which had lapsed into the tremor stage) indicating that as the first movements of the quake were north-south, so the last movements were.

Professor Marvin* noted a similar condition for the Washington seismogram of the Kingston, Jamaica, quake of January 14, 1907.

Knowing the position of the epicentre, that is, its distance from Ottawa, Laska's empirical expression for the relation between the various phases and distance does not appear to apply in this case very satisfactorily, at least not for the 'principal portion.'

We may take the distance as 3,400 miles, say 5440^{km}, this would require an interval between the first and second preliminary tremors of $6\cdot45^{m}$. If we recognize the first movement of the N-S pendulum as the beginning of the second preliminary tremors, in which case we must admit that the second preliminary tremors are transverse and not longitudinal waves like those of the first preliminary tremors, then the interval between the first and second as found on the seismogram is $6^{m}\ 30^{s}$ or $6\cdot5^{m}$, which is in close accord with the above empirical or theoretical $6\cdot45^{m}$. Correspondingly we should find the 'principal portion' to begin $16\cdot3^{m}$ after the first preliminary, that is, at $4^{h}\ 05^{m}\ 02^{s}$. Examining the diagram there is nothing thereabout to show the beginning of the 'principal portion' with a rapidly increasing amplitude.

The next earthquake to be recorded was on the morning of June 13, 1907. On the following day the press reported an earthquake of the preceding day at Kingston, Jamaica, at 1.20 a.m., which 'was especially severe at Port Royal, destroying the walls of the temporary buildings under construction,' also 'a severe earthquake was experienced yesterday at Valdivia, Chile. Several buildings and the railroad bridges were destroyed, and five persons were killed.'

If the above time for Kingston is correct we have evidently no record for that earthquake.

The seismogram of the 13th June shows somewhat the characteristics of the one just described for Ecuador.

Both Kingston and Valdivia are nearly due south of Ottawa, the former being about a degree west and the latter a little over two degrees east of our meridian. In distance, however, there is a great difference while the former is about 1,900 miles (3,000 km.), the latter is nearly 5,900 miles (9,400 km.) distant. Hence the phases of the quake should determine which earthquake was recorded. The earth was comparatively quiet preceding the quake, there were very few 'sawtooth' tremors recorded in the preceding hours, and those that were, were very minute, scarcely readable.

* Monthly Weather Review, Jan. 1907.

The E-W pendulum showed the first preliminary tremor at 4^h 30^m 46^s, amplitude $\cdot 7^{mm}$. At that same moment the N-S pendulum showed a minute disturbance, like an earth tremor, and this continued till at 4^h 41^m 04^s a decided movement, amplitude $1 \cdot 5^{mm}$, was recorded. The E-W pendulum after the first preliminary tremor showed little movement until at 4^h 41^m 00^s it too recorded a decided deflection, amplitude 3^{mm}. The amplitudes of both slowly decreased till 5^h 19^m when the traces were practically straight lines. Recognizing then the second disturbance as that of the 'second preliminary' we have for interval from the first 10^m 18^s, this would indicate a distance from the epicentre of 9,300 km., whereas our assumed distance is 9,400 km., a close and satisfactory agreement. The beginning of the 'principal portion' should occur $27 \cdot 9^m$ after the first preliminary, but in this case too, there are no marked oscillations corresponding to this time or near it. By a coincidence the interval of 10^m 18^s is approximately that between the first preliminary tremors and the beginning of the 'principal portion' for the distance of Kingston, and at the same time that between the first and second preliminary tremors for the distance of Valdivia.

TERRESTRIAL MAGNETISM.

Declination was generally obtained by means of a magnetic needle supported on a pivot and the whole attached to a transit by means of which the direction of true north was obtained. Both inclination or dip and intensity or total force were obtained with the dip circle. The latter was determined statically, Lloyd's method, where a dipping needle is loaded with a small fixed and constant weight acting in opposition to magnetism, that is, the earth's magnetic attraction is weighed, so to speak, against the force, assumed to be invariable, of gravitation. This gives the comparison of the forces in the plane of the magnetic meridian. Then the loaded needle whose magnetic constant is determined at a base station, is used as a deflector to a dipping needle whose polarity is not reversed as is done with the dipping needle used for the determination of inclination. The data are then sufficient to deduce the value of the force.

The method is simple, it is well adapted in connection with exploratory work, requiring less skill and manipulation and less patience than is necessary in the use of the fibre magnetometer. Lefroy in his extensive survey in Canada employed Lloyd's method. It is only applicable to a limited portion of the globe, being especially useful in the higher magnetic latitudes.

The instrument that is used at present is a Tesdorpf magnetometer, similar to those supplied to Drygalski of the 'Gauss' on her Antarctic expedition.

Of the three elements, the inclination is obtained in the usual way, common to all magnetic instruments, a symmetrical magnetic needle with cylindrical axis is supported on two horizontal agate edges. The plane of oscillation is in the magnetic meridian. If all the conditions were perfect then the inclination to the horizon shown by the needle would be the desired magnetic dip. To eliminate imperfections of figure, inequality of pivots or axis, unequal distribution of magnetism, observations are made in duplicate and in all possible positions of the needle together with reversal of its polarity, which latter is affected by means of two bar magnets.

The declination, however, is obtained not by a magnetic needle, which suffers somewhat in sensitiveness on account of pivotal friction, but by the direction of a suspended cylindrical hollow magnet. Formerly the suspending fibre was of silk, but now a metallic fibre, extremely fine, is used.

The horizontal force (total force a derivative) is obtained from deflection and oscillation observations. The principles involved in the two observations are simple. In the first—that of deflection—we obtain the ratio of the magnetic moment of a deflecting magnet whose constants are known to the earth's horizontal magnetic force, *i.e.,* there are two forces pulling at the suspended magnet, one that of the deflecting magnet, which is placed at a given distance from the suspended magnet, and in a horizontal line from the centre of the latter and perpendicular to its direction, and the other that of the earth.

In the second, that of oscillations or vibrations, by noting the duration or time of an oscillation, the product of the same two quantities is obtained. As the lines of force lie in the magnetic meridian, the total force could be obtained were it practicable to observe the oscillations in that plane. Hence the oscillations are observed in a horizontal plane. There is an analogy between these magnetic observations and those of gravity by means of a pendulum.

By noting the period of a pendulum at two stations we obtain a ratio of the force of gravity at the two places; similarly, when oscillations are noted with a permanent magnet at two points of the earth's surface, the ratio of the magnetic force is obtained. In each case, for gravity and terrestrial magnetism, the intensity of the force varies inversely as the square of the period of oscillation. The oscillating magnet is the one used as a deflecting magnet in the preceding case.

The constants of the magnet have been determined by Mr. R. F. Stupart, director of the Magnetic Observatory at Agincourt, the magnetic base station for Canada.

I have the honour to be, sir,

Your obedient servant,

OTTO KLOTZ.


Daily position of Pendulum Zero.
from March 7th to April 20th 1907.
S
E
W
N

FIG. 1.

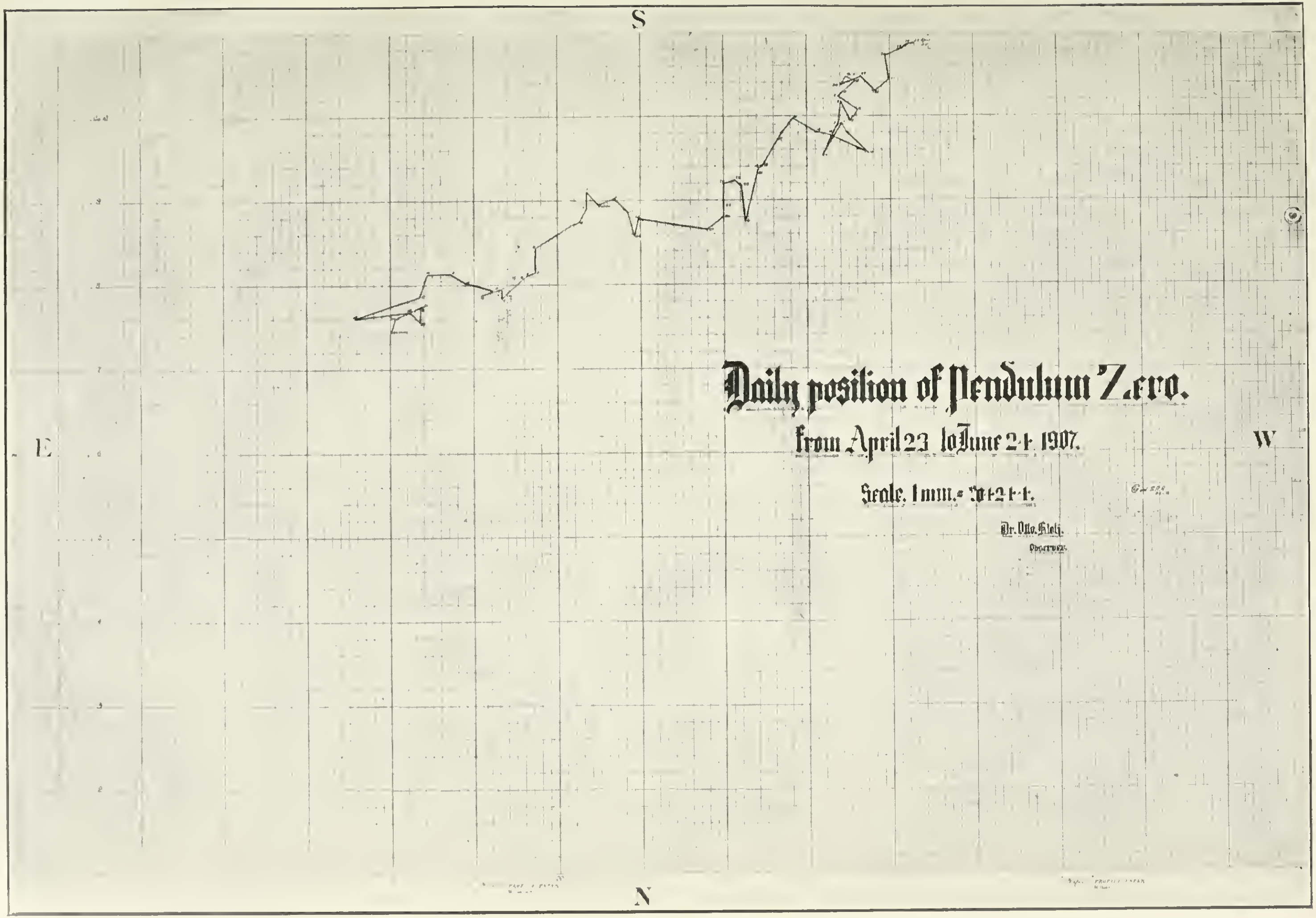
S
E
W
N
Daily position of Pendulum Zero.
from April 23 to June 24 1907.
Dr. Otto Klotz.
Observer.

Fig. 2.

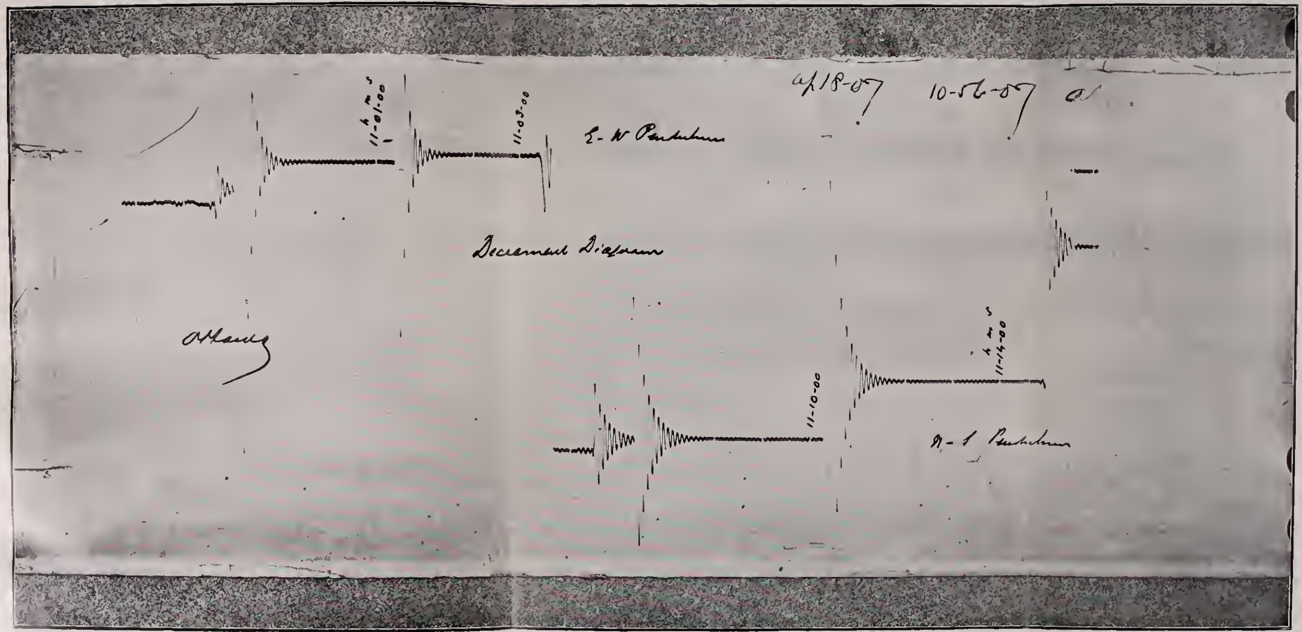
11-01-00
11-03-00
E-W Pendulum
10-56-07
Decrement Diagram
11-10-00
11-14-00
N-S Pendulum

FIG. 4.

APPENDIX 3.

REPORT OF THE CHIEF ASTRONOMER, 1907.

ASTRONOMICAL AND ASTROPHYSICAL WORK.

BY

J. S. Plaskett, B. A.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 3.

ASTRONOMICAL AND ASTROPHYSICAL WORK, BY J. S. PLASKETT, B.A.

OTTAWA, ONT., July 10, 1907.

W. F. KING, Esq., B.A., LL.D.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to present the following report of the work carried on by me and under my direction during the past year.

Since presenting my last report, considerable progress has been made towards getting the work arranged and systematized, but considerable remains to be done before it is completely organized. A certain amount of experimental and tentative work is unavoidable when an observatory is being started and new work initiated; indeed, it is only by intelligent experiment that any real progress can be made, and it has been my aim from the beginning by suitable experimenting to place our instruments and methods of work in as efficient a form as possible. Before entering into any details of the work, however, I wish to express my appreciation and gratitude for the readiness you have always shown in meeting any needs that have arisen either in the way of assistance or apparatus, for the very effective help you have so readily given me in many of the problems connected with my work, and for the advice and encouragement so willingly afforded me. To these must also be added the privilege of visiting the principal observatories of the United States, which you arranged for me. This visit proved of great value, as many ideas and methods were thereby obtained which have been and will still be of much service in the work here, and which could have been obtained in no other way than by a personal visit. A full report of this visit will be found below.

The greater part of my time, as in the previous year, has been occupied with spectrographic work and I have to report satisfactory progress in that line. As outlined last year, the work has been confined almost wholly to determining the velocity curves and orbits of some spectrographic binaries, and, although I can only report one binary, α Draconis, as completed, the preliminary elements of i Orionis have been obtained and work on η Piscium, ν Geminorum, η Virginis, η Bootis, α Corona Borealis, and o Andromedae is well under way. Besides these stars a number of other binaries as well as some early type stars are under observation, but, up to the present, none of the plates have been measured and reduced. The same difficulty occurs here as is felt elsewhere, the practical impossibility of having the measurement and reduction keep pace with the observing. This is especially necessary in the case of binary stars to determine at what part of the period observations are most needed. With the additional assistance you have provided, however, and with the spectro-comparator, whose purchase you have authorized, together with a simplification in the method of reduction, there seems to be good ground for believing that this difficulty will be to a great extent obviated in the future. I wish to report in this connection the very satisfactory work of W. E. Harper, who has during the year he has been with me, measured and reduced a large number of spectrograms in a most careful and efficient manner.

The designing and the making of the detail drawings for the new combined three-prism and single-prism spectrograph, which is now completed and in regular use, occupied considerable time. Besides the above, the working drawings of the mechanism for the coelostat telescope have been completed, and the work, which is being done at the Victoria Foundry, Ottawa, is well under way. A new form of polarizing photometer has been designed and the drawings made, while the instrument itself has been constructed in our workshop. These will be described in more detail below.

The workshop has proved itself an invaluable adjunct to the observatory, and I think we are to be congratulated on obtaining so able a mechanician as Mr. Mackey to preside over it. During the year he has been employed, all the mechanical parts of the new spectrograph, (the manufacturers price for a similar but less complete instrument being $2,000) have been constructed, including an outside temperature case of aluminum. The photometer above referred to has been completed and a travelling wire micrometer for Cooke Transit No. 1, is nearly finished. Besides these larger pieces of work, many small accessories have been constructed and the numerous repairs, so frequently required wherever instruments are used, attended to.

The supervision of this work and the testing and adjusting of the new spectrograph have occupied considerable time, as has also the arrangement for the automatic heating of the temperature case. Owing to the great difference between day and night temperature in the equatorial room, the spectrograph has frequently to be maintained from 5° to 10° C higher than the surrounding air, and, under such conditions, it is difficult to prevent the radiation and conduction then going on from making itself felt in a lowering of the temperature within the prism box, this taking place at the rate of about 0·1° C per hour, if the outside temperature continues to fall. However, most of the difficulty has, by suitably arranging the heating coils, been successfully overcome.

Three special investigations on spectrographic work have been undertaken, two of them completed, the third only partially so. The first dealt with the form of image given by the system of objective and correcting lens. I had long felt that there was need for some work in this line, especially after my trouble of the previous year with the correcting lens as detailed in the last report. This investigation attacked the problem in various ways and showed that the image given was at least twice as large in diameter as it should be. The paper was published in the Astrophysical Journal for April, 1907, and is given as Appendix A to this report. It is hoped as a result of this work to obtain a correcting lens giving a normal-sized image. Such a lens has been computed by Dr. C. S. Hastings, and is now being made by the Brashear Company. It should very materially reduce the required exposure time and moreover, by the more uniform illumination of the collimator objective thereby obtained, ensure greater freedom from chance of systematic error.

The second investigation referred to was on the spectrum of *o* Ceti, the well known variable star, which reached an unusually high maximum last December and was well within the range of our equipment. Several facts of interest were elicited from the measures of the spectra obtained, which are detailed more particularly in the copy of the paper below (Appendix B), which was published in the Journal of the Royal Astronomical Society of Canada, vol. No. 1.

The third incompleted investigation was on the influence of slit widths on the accuracy of velocity determinations and, although not completed, the results show that the slit can be widened considerably in early type stars with few lines without much increasing the probable error of the determination of the velocity. The whole question will be investigated in greater fullness in the near future, with especial reference to the new spectrograph and the different dispersions obtainable by it.

Since the last report the solar camera has been in regular use and a photograph of the sun's surface, recording the spots, has been made on every clear day. This work has been attended to either by Mr. Harper or myself, but now that Dr. DeLury has been appointed he has taken charge of it. No other solar research has yet been commenced owing to the delay in the erection of the coelostat house. As stated before the heavy mechanical parts of the telescope are being made at the Victoria Foundry. The secondary plane 20″ mirror and the concave of 18″ aperture and 80 feet focus have been ground and figured by Brashear, and are now stored in the instrument room. A combined collimator and camera objective of 6 inches aperture and 23 feet focus, also figured by Brashear, has been obtained, and I am glad to report that, through the kindness of Dr. Brashear, we are now in possession of a 6 inch plane grating of 12,500 lines to the inch to be used in connection with the above objective. The optical parts of the installation are all ready and, as soon as the building is completed, work can be commenced at once.

It was found difficult, indeed practically impossible, to obtain satisfactory results with the registering wedge photometer, and work with it has been abandoned. I designed a photometer which depends on the comparison of the star with an artificial star, the latter being varied in intensity by the rotation of a Nicol prism in a polarized beam from it, this variation being a function of the angle of rotation. This design was completed, and the necessary optical parts for it obtained about the New Year, but the press of work in the workshop has prevented its completion until now. It is hoped that, by its use, accurate results in the measures of variable stars may be obtained.

A beginning has been made in micrometer work with the equatorial by Mr. Motherwell, recently appointed. It is proposed to obtain measures of those double stars within the range of the telescope of which the measures are few in number, and of those binaries which are in sufficiently rapid motion to require frequent measurements. It is also proposed to, as far as possible, measure the positions of any comets visible. Mr. Motherwell is also including in his work, at your suggestion, the observation of the time of occultations of the brighter stars by the moon. For this purpose and for photometric work on the brighter stars, the 4½″ Cooke equatorial telescope is to be mounted on the roof of the observatory and can be used when the 15-inch is otherwise engaged.

The popularity of the Saturday open nights for visitors has continued unabated, the average attendance being over 50 and on several nights having been over 100.

That there is a real interest in astronomy in the Capital is shown not only by these figures, but by the splendid membership obtained for our Astronomical Society, by the large attendance at the meetings and the interest in the proceedings.

The care of the instruments has taken up considerable time, and one is frequently interrupted in important work to give out a minor instrument. I propose, with your permission, to entrust the bookkeeping part of it to Mr. Motherwell, reserving only the general supervision over the instruments and attention to the necessary repairs.

It is hoped, now that the staff under my direction has been increased by three. and that the instruments and method of work are gradually getting into satisfactory condition, to much increase the output of useful work in the near future. I feel, however, that considering the circumstances, a good beginning has been made and that, as the work becomes more and more systematized, both the amount and quality will increase.

VISIT TO OBSERVATORIES.

Lick Observatory.

When, by your kindness, I had the privilege of visiting the principal observatories in the United States, the first one to be reached was the Lick on Mt. Hamilton in California. The journey was made from Ottawa by way of the Canadian Pacific Railway to Vancouver and thence from Seattle through Portland to San Francisco, reaching there on Sunday, August 26. Mt. Hamilton is reached from San José, 50 miles from San Francisco. From San José a daily stage makes the 25 miles of mountain climb in about 5 hours. The observatory is commandingly situated on the summit of Mt. Hamilton, at an altitude of about 5,000 feet, and, owing to its comparative inaccessibility is surrounded at a somewhat lower level by a number of other buildings serving as dwelling houses for the astronomers, as offices and workshops, &c. In fact the summit is like a small town, has its own electric light plant and water works system, its school, its boarding houses, &c., all presided over in a paternal way by the director of the observatory, Dr. W. W. Campbell. I had not known, until I reached San José, the inaccessibility of the observatory nor of the fact of there being no hotel accommodation at the summit, and I was in a quandary as to arrangements for accommodation during my visit. I had written Dr. Campbell of my proposed visit, but, owing to his absence, had received no reply. However, I was heartily welcomed at the summit and kindly and hospitably entertained by Dr. and Mrs. Campbell, who did everything in their power to make my stay a most pleasant one. I can safely say that they succeeded fully, and I wish to record here my appreciation of their kindness to an entire stranger.

I wish also to mention that every member of the staff seemed to take pleasure in showing me every detail of their work, and as a consequence, I had both a pleasant and profitable time.

The summit of the mountain was blasted off to form a level place for the observatory building, which faces the west, overlooking the Santa Clara valley and San José. The 75-foot dome containing the 36-inch telescope is at the south end, and the dome for the 12-inch telescope at the north end of the building. The offices in the central part of the building between the domes are entered from a hall at the rear running the whole length of the building and entering the large dome at one end and the small one at the other. In this hall, arranged as transparencies, in stands for daylight or artificial illumination, are examples in the form of photographs of the different kinds of astronomical work carried on at the observatory. They comprise photographs of the sun and sun spots, of the solar corona and prominences, of the spectrum of the reversing layer and chromosphere, photographs of the moon at different phases, of some of the planets, and of star clusters and nebulae. There are many fine examples of the latter taken with the Crossley reflector by the late Director, Professor J. E. Keeler. There are also enlargements of different types of stellar spectra made by the present Director, Dr. Campbell, who has made a specialty of stellar spectroscopy and radial velocity work, and practically revolutionized the methods of determining the velocities of stars in the line of sight.

These transparencies, as well as numerous photographic prints on the walls, serve to render the hall very interesting to visitors of an astronomical turn of mind and, during the summer, there is hardly a day that does not bring its quota. As at Ottawa, visitors are, on Saturday evening until ten o'clock, allowed the privilege of a look through the telescope, and this I learned is frequently taken advantage of by large numbers who make the 25 mile trip from San José for that purpose.

On the afternoon of my arrival, Dr. Campbell showed me over the observatory, introducing me to the various members of his staff and explaining the nature of the work under way at the observatory. The amount of work accomplished is marvellous, and as to the quality, there is no need to speak of that as its reputation is world wide. The climate of Mt. Hamilton is probably better suited for astronomical work than that of any other observatory on the globe. For eight months in the year practically every night is fine, and I can testify that the seeing is much better there than at any other observatory I visited. Dr. Campbell told me that the average number of working nights was 250 in a year, and the work is so arranged and divided that every night and all night long is utilized. The custom there is to divide the nights into two portions, one person using the telescope from dark till midnight and then being relieved by a second observer, who works until dawn.

The work undertaken is quite wide in its range, embracing nearly every class of astronomical activity. Spectrographic work, the radial velocity of stars, has perhaps the greatest attention paid to it, but micrometric work is a good second, and besides, considerable attention is devoted to observations with the meridian circle. Moreover the Crossley reflector, under charge of Dr. Perrine, is doing splendid work in the photography of stars and nebulae; while photometric work also receives attention.

The determination of the radial velocities of the brighter stars is the especial work of the director, and he has not only revolutionized the methods of obtaining accurate values, but has now probably more data concerning radial velocities than all other observatories engaged in this work combined. Several thousand star spectra have been photographed, and the work of measurement is making good progress. When his catalogue of the radial velocities of the brighter stars has been completed, our knowledge of the universe will be very considerably increased. The Mills spectrograph attached to the 36-inch equatorial is the instrument with which this work has been done, and this instrument with the method of measurement and reduction employed are fully described by Campbell in the Astrophysical Journal, VIII., p. 123. The optical parts of this spectrograph have, however, recently been remounted in an ingenious and original manner after designs by Dr. Campbell who very kindly explained to me the whole mechanism. It consists briefly of a steel box, oblong shape, made of two $\frac{1}{8}$-inch thick plates on the sides joined together about 3 inches apart by braces and cross braces and by plates, which form the channels or tubes along which passes the light from slit to collimator lens and from camera lens to plate, the prisms being mounted on one of these plates in the proper position. These plates are further stiffened by being screwed to castings which act as the ends of these tubes and the points of support of the instrument. The whole spectrograph is thus complete in one part, homogeneous and self contained. An axis, passing through the prism box and near the centre of gravity of the spectrograph, is supported in bearings on a truss framework rigidly attached to eye end of the equatorial. This axis can rotate, if necessary, in these bearings which are moveable in slides parallel to the optical axis of the telescope. The other point of support is on the tubular casting projecting from the box to which the slit is attached and which thus forms one end of the collimator. This slides in a ring pivoted between two points attached to the same truss. Thus it is not possible for any stresses to be introduced in the spectrograph proper by any flexure of the truss, and this is a decided improvement over the usual form, where truss and spectrograph are so connected together that flexure of the former is likely to introduce a similar trouble in the latter. Again, a change in the star focus is compensated by moving the spectrograph as a whole and not the collimator tube only.

Dr. Campbell informed me that flexure is entirely eliminated by this form of construction, and that I can readily believe. He further stated that if he were building another instrument he would construct it of brass which is amply strong to prevent flexure, which is easier to work, and which, with the usual type of collimator and camera lenses forms a combination which requires only very slight changes of focus for changes of temperature. The old Mills spectrograph had $H\gamma$ central, the new $\lambda 4,500$. I was told, however, that not much advantage is thereby gained in exposure time over $H\gamma$ central, this being probably due to two causes:—first, the focal length of camera requires increasing to obtain the same linear dispersion in the two cases, second, a denser spectrum is required around $\lambda 4,500$ to get the same accuracy. He advises about $\lambda 4,400$ as the most useful compromise.

The compactness of the instrument allows the temperature case to be small and neat. The case is supplied with coils for electric heating, the temperature being maintained automatically constant by an electric contact thermometer working in conjunction with a relay for controlling the heating current. As this responds to a change of temperature 0·2 C, the temperature in the prism box will vary only very slightly during a night's work.

The outside temperature case is placed on the spectrograph and the automatic heating arrangement switched on after the dome has cooled down and only shortly before starting the evening's work as the difference between day and night temperature on Mt. Hamilton is small, about 3° C. The automatic control works admirably, as the reading of the inner thermometer did not change appreciably during 4 hours working.

I had the privilege of staying with Dr. Campbell while he made several exposures on the spectrograph, and observed the remarkable ease with which the large equatorial is handled and the convenience of all the auxiliary apparatus required. The guiding is now performed by the reflecting slit method, and this method seems to me decidedly preferable to that in which one guides by the light passing through the slit jaws and reflected from the front surface of the first prism. I had an opportunity of comparing the guiding and following with that of our own telescope and, considering the great focal length of the instrument, practically three times as great as our 15-inch, the image remains remarkably steady and is very clear and distinct. This is undoubtedly due in great part to the exceedingly steady and almost perfect seeing which Mt. Hamilton possesses, but the quality of the image is also due to the magnificent objective of the 36-inch.

Dr. Campbell was most kind in giving me every possible assistance that might be of service in our spectrographic work and in many points and details his experience and advice is invaluable. I can only mention here a few of the points that occur to me as of sufficient moment to record.

The exposures actually required for stars of different magnitudes are found to vary directly as their intensities, *i.e.*, the exposure is increased 2·5 times for every magnitude fainter. This has not been found to be the case at Ottawa, the faint stars requiring relatively longer exposures than the bright stars. A well known property of the photographic plate by which, when the product of light intensity and time is constant, equal densities in the resulting negatives do not result when there are considerable differences in the light intensities probably accounts for this difference in the case of Ottawa, but why it should be different at the Lick is not evident. The comparison spectrum is introduced beside the star spectrum by a separate attachment at each side of the slit, reflecting the spark light to the collimator lens by a special diagonal prism. Hence when the spark spectrum is exposing there is no interference with the star spectrum which is being exposed at the same time. The exposure on the spark is divided into 4 parts at $\frac{1}{8}$, $\frac{3}{8}$, $\frac{5}{8}$ and $\frac{7}{8}$ of the time of star exposure. The titanium comparison is now used with the new Mills, as the iron lines in the region around minimum deviation λ 4,500 are few in number and faint; and as no air lines appear in the titanium spectrum, no self induction is required in the circuit. The wave lengths of the titanium lines are obtained from Rowland's Solar Spectrum tables.

The settings for the slit in the star focus and for the camera focus are functions of the temperature and are taken from tables prepared from actual tests of these variables under varying temperature conditions. In this connection I learned that the camera focus was determined by definition tests, which according to my experience are not sensitive enough to determine the focus accurately within two or three tenths of a millimetre. This may be due to some aberrations in our camera lens preventing the sharpest definition at any point, but, so far as the resulting spectra are any evidence, there is little difference between it and the Lick. With the method described by me in our last report, a change in focus of less than a tenth of a millimetre is easily recognized, and, owing to the importance of correct camera focus to prevent systematic displacements of the lines and to the ease and quickness with which the focus is determined, the method I have used appears preferable.

Campbell's method of determining the collimator focus and the star focus are very ingenious and reliable and exhibit, especially the latter, the care and attention to details that help to account for the remarkable work he has done and is doing. The collimator focus is determined by pointing its objective to the sky and holding against its wide open slit a small photographic plate. Star trails at slightly different settings soon give a very accurate value of the true focus. In setting the slit in the focus of the objective and correcting lens, the first step is to determine the difference in focus between the spectral lines and the dust lines, as it is only in rare cases that no astigmatism is present in the prisms and the two foci coincide. The camera focus is then set so that the dust lines are in focus, the slit opened widely and a number of spectra made at different settings of the star focus. The narrowest spectrum will evidently be the one in focus. I am indebted to Dr. Campbell for pointing out the above precaution in regard to the focus for the dust lines, as the necessity for it had not occurred to me.

In the measurement of the spectra, I was informed that practically every known method of reduction had been tried, and they are at present using the method developed by R. H. Curtiss of comparing the positions of the star lines with the same lines in a standard solar spectrum of the same dispersion. This method of course is only applicable to stars of the second type, whose spectra are similar or nearly similar to that of the sun. With early type stars I presume some method of reduction to wave length is used, but astrophysicists will, I am sure, look forward with interest to a discussion of the relative values of the various methods, which it is to be hoped Dr. Campbell will find time to prepare.

The measuring microscopes used are by Toepfer & Sohn, and similar to the Ottawa microscope except that they have no second movement at right angles as is the case in our machine. Two settings are made on each star and comparison line in each position of the plate under the microscope, the average variation being two units in the third place. The spectrograms are all of good quality for measurement, although their spectra of the brighter stars are no better than ours they have a very decided advantage when it comes to the fainter stars. Owing to flexure and to temperature changes, the definition becomes diffuse and washed-out looking with our modified Universal spectroscope, while, owing to freedom from flexure and to good temperature control, the spectra of faint stars made at the Lick are of practically as good quality as those of the brighter stars.

The spectra of stars as faint as the sixth photographic magnitude can be obtained with the Mills spectrograph, although upwards of two hours exposure is required. For stars fainter than the sixth magnitude, a spectrograph of lower dispersion is required, and at Mt. Hamilton they use a single prism instrument giving only one-fifth the dispersion of the Mills. The outside limit with this small dispersion is the eighth magnitude, and even these are only obtained with a very long exposure. This instrument is built up from the telescope truss and collimator section of the old Mills instrument, using a light flint prism as dispersing medium. The camera is stiffened by a tubular brace from the collimator section to the camera, and Dr. Campbell acquainted me with a curious fact in connection with the material of this truss. The collimator section is of steel, the camera section of brass. A brace or truss of steel was found to give no displacement of the spectral lines for change of temperature, while a brass truss gave a marked displacement. It is evident that, if necessary, a composite brace could be constructed that would neutralize any temperature displacement. The single prism instrument is used chiefly in special investigations, such as those on variable stars, which in their minimum phase go beyond the limit of the Mills spectrograph.

The spectrographic equipment and methods proved most useful and interesting to me, and the ideas and wrinkles gained have proved of the greatest value in our work and, even if nothing more had been learned, would have been worth the trip.

Another interesting feature of the observatory is the Crossley reflector. This telescope has quite an interesting history. Donated by Mr. Crossley to the Lick observatory it was, after much time and trouble, put into effective condition by Prof. Jas. E. Keeler, the late director of the Lick observatory. He made a large number of beautiful photographs of nebulae, discovering many new ones. Indeed it has been stated that it was principally owing to the enormous amount of labour connected with this work that his death was hastened. There is no question that he obtained magnificent results with a very poorly mounted instrument. Since Dr. Perrine has had charge of the reflector an entirely new mounting has been made after a quite original plan, which I am informed works admirably. That the work being done with the reflector has not suffered is evidenced by the discovery by Dr. Perrine of the 6th and 7th satellites of Jupiter. The polar axis is of tubular form built up of boiler plate with cast ends, on which are the journals rotating in bearings on separate piers. The body of this tube is eccentric with respect to the journals and the declination axis passes through it perpendicularly. The telescope is mounted on the declination axis at the side of the tube nearest the centre, thus the eccentric position of the tube helps to balance the weight of the mirror and its tube. The driving is effected by means of two long sectors into which two worms, each driven by the clock, gear. The one of these sectors that is idle is driven backwards while the active one is driven forward. As soon as the latter gets to the end of its run, an automatic arrangement unclamps it, clamps the idle one and the telescope's motion is continued without change. Owing to the length of these sectors and to the care with which they were cut and hobbed in place, the telescope drives so accurately that practically no guiding is needed for 15-minute exposures, and only occasionally in longer. The guiding is done by a double slide carrier, shifting the light plate rather than the heavy telescope. In satellite work, the motion of the satellite relative to the stars is computed, and the guiding cross wires moved at short intervals so that the plate exactly follows the satellite although making trails of the stars.

I was much interested in the plates, shown to me by Dr. Perrine, in which the 6th and 7th satellites of Jupiter were first seen. Also in a large number of beautiful photographs of nebulae and clusters which are soon to be reproduced in a book. The predominant form of nebulae as shown by these plates is spiral thus indicating the necessity of a revision of the Laplacian hypothesis. The star plates obtained, which are 3¼″ x 4¼″ in size, are measured by either one of two machines, the Repsold or the Stackpole, neither of which are entirely satisfactory according to Dr. Perrine's experience. The Repsold machine has a silver scale as a standard, the settings being made by a double micrometer microscope on the star image and the microscope being then tilted to point on the scale, thus giving the x co-ordinate, the y being obtained on a second scale at right angles. The Stackpole machine has a simple microscope provided with cross wires and the plate is set so that the star is at their intersection. The scale readings are made by two auxiliary microscopes on glass scales, no micrometers. I had the privilege of being with Dr. Perrine, while he was making plates for the redetermination of the position of the new satellites of Jupiter, and the reflector now seems to work very smoothly and regularly, and everything is arranged more conveniently then when Keeler did his work.

As from everyone at the Lick with whom I came in contact, I received many kindnesses from Dr. Aitken who is responsible for the micrometer work with the 36-inch. This work consists chiefly of the measurements of position angle and distance of double stars, and also the survey of the whole available sky at Mt. Hamilton with the 36-inch for the discovery of double stars. In such a systematic and thorough way is this work carried on that when he completes it there will be practically no more doubles to discover. Already by this method about 1,500 new doubles have been discovered, and these doubles are all comparatively close, to the best of my recollection none are noted which are farther apart than 5 seconds. His method is both simple and thorough. All stars of magnitude 9·0 or greater in the B.D. are entered upon cross-section sheets in their correct relative positions, each sheet being about 40 minutes wide in declination and covering about 15 minutes of time in right ascension. Every star on this list is carefully examined by the large telescope and, if double, is measured and recorded. Each double, both new and old, is measured at three different times, recorded on the sheets and transferred to a table. A card catalogue of the most important binary stars is kept, and measurements are made on each of these as occasion arises and when a measurement is required to get a complete orbit. On these cards are entered all previous measures, and also the approximate dates when future measures are desirable. His system of keeping track of what has been done and what is required to be done in double star work is very complete and well arranged to avoid loss of time and unnecessary duplication of work. I was much interested in comparing the star images at Mt. Hamilton with those I had seen at Ottawa, and Dr. Aitken kindly allowed me every convenience for so doing. The night I saw through the 36-inch, the seeing on their scale (5 perfect) was only fair, a little less than three, but even then was much steadier than any I had observed at Ottawa. A double of 0·25″ distance was well separated in the telescope, whose theoretical separating power according to the formula $d = \frac{1 \cdot 22\,\lambda}{r}$ is about 0·15″. The appearance of the star image within and without focus, making allowance for the difference of seeing, was practically the same as that given by our 15-inch.

On the next night Dr. Aitken was observing with the 12-inch Clark telescope, seeing fairly good, between three and four. A double star 0·4″ apart, just within the theoretical limit, was separated, but not easily. The star images were beautifully small and crisp and the diffraction rings very clearly defined. The appearance within and without focus was practically identical, and I can readily believe the director's statement that this is one of the finest if not the finest objective ever made. The seeing was immeasurably better than any I have ever experienced in Ottawa.

A six and one-half inch meridian circle by Repsold is completely fitted with all the necessary accessories. There are full sized collimating telescopes at the north and south and also a full sized collimating lens for the azimuth mark about 100 feet away. This is placed directly below the southerly collimator. The irregularities of the pivots are observed by means of mirrors on each end of the axis, viewed through a telescope to the east and west. Tucker, the astronomer in charge of the positional astronomy, was away on a vacation during my visit, and consequently, I did not get any information concerning this branch of the work.

Numerous other pieces of research which arise from time to time are carried on at the Lick observatory and there are other lines of work which also have some time devoted to them. Photometric work is one of these, the instrument used being the Harvard type of wedge photometer on the 12″ equatorial, the measurements being used to obtain the light curves of variable stars. Maddrill who was doing the photometric work claims the results with this type of photometer are reliable to about the tenth of a magnitude. The measurement of the position of comets is also on the programme of the observatory and is generally undertaken by the junior members of the staff.

The esprit de corps of the whole staff is very good. Everyone I talked with was enthusiastic about his own work and the work of the observatory and proud to be a member of its staff. The quantity of work turned out is enormous and its quality is universally recognized. The Lick observatory has of course a very great advantage over every other observatory in the character of the climate and its eminent suitability for astronomical observations. Not only are the number of good nights much greater than anywhere else, but the quality of the seeing is also superior to that elsewhere.

During the summer months the observers can be almost absolutely certain of having every night fine, and every one with experience knows what an advantage it is in many lines of work, to be able to obtain an observation whenever necessary. I spent four days most pleasantly and profitably at the Lick and could with much advantage have considerably extended my visit, but as my time was limited, it had to be made short. I left the observatory with regret, but with very pleasant memories of the kindness shown to me.

The Solar Observatory of the Carnegie Institution.

Pasadena was reached on Sunday, September 2, and an attempt was made to find Professor Hale, but without success. I found that he was in Santa Barbara for a few days, and I looked up Professor Ritchey, the Superintendent of instrument construction, who invited me to come around to the offices on the next day, Labour day. Although the shop was to be closed, the unloading of some of the heavy parts of the 60-inch reflector required his presence. On the following morning Professor Ritchey showed me the different points of interest in the instrument and optical shops of the observatory which are models for convenience and accuracy of working. The instrument shops are fitted with the most modern machine tools, lathes, milling machines, planer, shaper, grinder, drills, &c., and several men are continually employed. The principal line of work carried on here is the construction of the new instruments required at the observatory and laboratory, and, as so much of the work is new, requiring special apparatus, the facilities of the shop are taxed to the utmost. Besides much preliminary experimental work, the very complete and beautiful spectroheliograph in regular use at the observatory has been made. The globe measuring machine or helio-micrometer has been developed and finally completed. The solar and laboratory grating spectrographs with all their accessory appliances have been constructed here, to say nothing about the many smaller pieces of experimental apparatus continually required in any line of original physical or astronomical research. The work upon which most of the men were engaged at the time of my visit consisted of the driving clock, slow motions, and small accessories of the mounting of the 60-inch reflector which is now under construction. The mirror is being figured by Professor Ritchey, and the heavy parts are being made by the Union Iron Works of San Francisco.

The optical shop is a very interesting feature of the equipment as Professor Ritchey has introduced some novel methods in the grinding and figuring of mirrors, and the machine used in the finishing of the 60-inch mirror is arranged to give a number of different motions to the grinding or polishing tool and to the mirror. The figuring of the 60-inch mirror is being effected by a quarter-sector tool and Ritchey claims that he can do everything with it that can be done with the full sized tool with the advantages of less weight and greater ease of handling. Another noticeable point is the scrupulous care taken in cleanliness. Varnished walls, double windows, cloth packed double doors and close grained hard cement floors are some of the precautions employed. Whether such extreme care is necessary is questionable as the Brashear Company make surfaces of the most beautiful polish, and with never a scratch, without taking apparently a tithe of the care that is taken in Pasadena. The 60-inch mirror was being tested by zones at the centre of curvature, but they are at present figuring a 36-inch flat to test at the principal focus. I have no doubt that when finished, the mirror will have a figure as perfect as it can be made and that some beautiful results in nebular photography will be obtained by it, especially in the transparent and rarefied atmosphere of Mt. Wilson.

I examined with much interest the drawings of the mounting for this mirror whose design, due to Professor Ritchey, is ingenious and admirable. Although I am no judge of the quantity of material required, the polar axis and principal moving parts seemed to me unnecessarily heavy, but the error, if error it be, is certainly on the safe side. The mirror with its accompanying skeleton tube is to be carried in a fork on the north end of the polar axis, which is about 18 inches in diameter at the upper end, having a central hole some 9 inches in diameter, along which the beam of light is to be transmitted when the instrument is used in a Cassegrainian form. The weight of the mirror, tube, fork, polar axis, driving gears, worm and all moving parts is to be counterbalanced by a cylindrical float 10 feet in diameter, between the fork and the outer bearing, which will revolve in a semicircular trough filled with mercury. The upward thrust on this float is nearly equal to the weight of the moving parts, and there consequently should be little friction in the bearings. The driving worm wheel is 10 feet in diameter, it is to be cut in place on the axis and finished perfectly smooth by grinding with a worm. It is hoped that owing to its large diameter and to the care with which it is to be finished the driving will be uniform and regular.

An erecting shop has been built in the yard beside the main shop, in which the reflector is to be entirely set up and placed in thorough running order before being taken up on the mountain. A travelling electric crane is installed to handle the heavy parts, two or three of which, such as the fork and polar axis, weigh in the neighbourhood of ten tons each. In order to get such massive pieces to the summit of the mountain, a trail is being built up the mountain at great expense, and actual transportation is to be accomplished by a special automobile, each wheel driven by a separate electric motor.

Many interesting details of shop methods were kindly explained to me by the foreman, Mr. Jacomini, particularly those relating to the cutting and grinding of worms and worm wheels, the method of making and grinding curved slits, and the cutting of bevel gears. Many useful shop wrinkles were obtained, such as the use of a small motor for a portable emery grinder, and of a spring tool for cutting threads.

I examined with much interest the measuring and computing division of the work of the observatory which is now under the charge of Professor W. S. Adams, and is all done at the Pasadena office. There are a number of measuring microscopes for spectra by Gaertner and a plate measuring machine of the same maker, but the most interesting machine in the division is the globe measuring machine, or helio-micrometer as Professor Hale calls it, for determining heliographic positions of spots, faculae, flocculi, &c. The original form of the instrument consisted simply of a ruled globe divided by meridians and parallels into sections of a degree square, on which the image of the solar photograph was projected by a lens of the same focal length as the one with which the negative was taken. In such a case, placing the globe with its equator, poles, and prime meridian corresponding to the position of the equator, poles and prime meridian of the sun when the negative was made, the position of any point on the negative can be at once read directly on the globe, saving considerable measurement and computation.

In the improved form the plate and globe are placed side by side and illuminated strongly by electric light. At the distance of 60 feet, the focal length of the concave mirror of the Snow telescope, two concave mirrors reflect images of these into two telescopes, side by side, directly above the globe and plate, and these images are or can be superposed on one another by totally reflecting prisms into a single eyepiece. The globe itself has no graduations, but has an equator and principal meridian ruled on it, while the position of the globe with respect to two axes at right angles to one another is determined by graduated circles which can be read by telescopes near the eyepiece above mentioned. A cross wire is set on the spot whose position is required, and the globe is then rotated by means of slow motion handles until the intersection of equator and meridian coincide with the cross wires and therefore with the spot. The reading of one circle gives the heliographic latitude and of the other the heliographic longitude of the spot, without any computation whatever.

Prof. Hale returned from Santa Barbara on September 5th, and at first proposed to go up the mountain with me, but later found that he would be unable to leave Pasadena. He was very busy during the time of my visit with his investigation into the cause of the characteristic phenomena in sun spot spectra, which has since been published, and there was being installed for laboratory researches in connection with this investigation a transformer for an electric furnace with a capacity of 50,000 watts and also a transformer capable of delivering 5,000 watts at 1,000, 2,000, 4,000, 8,000, 16,000, 32,000, or 64,000 volts for powerful spark work. Professor Gale, who looks after the physical side of this and similar investigations, was, however, going up to the observatory, and I had the pleasure of his company and of Mr. Rainer of the National Physical Laboratory of England, who was visiting Pasadena at this time.

The only present means of reaching the summit is by horse or mule back and, after taking the street cars to the foot of the trail, one has to ride on an animal the remaining 9 miles of winding mountain trail through the frequently precipitous canyons to the summit. The trip, which required about 4 hours to make, was quite a pleasant one and the summit was reached about six o'clock. We at once went to what is called the Monastery, the bachelor quarters of the observers, and were introduced to the staff at that time working upon the mountain. I will refer to each more particularly when I come to speak of the work done on the mountain. The Monastery consists of a series of bed rooms with a common living room or library and dining room. The library has the principal astronomical and scientific periodicals on file together with a fair collection of the most useful books, which are, I believe mostly from Professor Hale's private library. The buildings are distributed over a considerable area on the mountain top, the Snow telescope house being about three-eighths of a mile from the Monastery with the laboratory and other temporary buildings between. The view from every part of the peak is magnificent, mountains after mountains to the limit of vision on the one side, and on the other the cities of the plain, Los Angeles and Pasadena, with the Pacific beyond.

The number of observers on the mountain at the time of my visit was seven. Of these Mr. Ellerman, who was the senior officer, is astronomer in charge of the solar work on the top of the mountain, Professor Gale has charge of the conjoined physical research with Mr. Olmstead as his assistant, Mr. Palmer is assistant to Mr. Ellerman, looking after the bolographic work with the Snow telescope. In addition to these regular officers of the observatory, Mr. Abbot of the Smithsonian Astrophysical Observatory and his assistant Mr. Ingersoll were working during the season on Mt. Wilson in determinations of the solar constant, while Professor Nichols of Columbia, another guest for the summer was doing some work on the absorption of gaseous vapor.

I was most interested in the work of Mr. Ellerman, as it was much on the same line as we propose to carry on ourselves, but I will speak first of the work being done by other members of the staff and by the guests.

Professor Gale and Mr. Olmstead were at work in the laboratory obtaining spectra of the elements most affected in sunspots. Such spectra were made with a high and low temperature arc, or in the arc and the flame of the arc, to compare the difference between the lines in the two cases and to further compare the lines so affected with those affected in sun spots. They use, for all this work, the Littrow type (with combined collimator and camera objective) of grating spectroscope, which is found to be both convenient and accurate. A number of spectra can be made on one plate, which is placed directly below the slit, as it is movable vertically by rack and pinion.

Mr. Palmer is using a bolometer to determine the energy curve at different points of the spectrum over a diameter of the sun. The bolometer is arranged to give a continuous record of the energy as the sun's image drifts across the slit. The image is in this case formed by the Snow telescope and, as steadiness of the solar image is not necessary, the work is usually done in the middle of the day when the definition is too poor for spectroscopic or spectroheliographic observations.

Mr. Abbot with Mr. Ingersoll as assistant has quite an elaborate apparatus, installed in a temporary building on the summit, for the determination of the solar constant and of variations in it. A continuous bolographic record of the solar spectrum from the ultra violet to the intra-red, inclusive, is obtained and the energy curve thus derived is integrated and calibrated by various methods so as to give very accurate values of the solar constant. Mr. Abbot believes the values he obtains are correct to one per cent and he has hence been able to detect a variation in the value of the constant between 2·0 and 2·3 calories. He has not as yet been able to connect this variation into any periodic relation with other phenomena such as spots, prominences, or other disturbances. The temperature changes on the earth's surface that are of a general as distinguished from a purely local character, follow markedly this variation in the solar constant, and Mr. Abbot states that one should be able to predict, considerably in advance, the probable temperature.

The work with the Snow telescope, which had been done conjointly by Messrs. Ellerman and Adams, the former taking the photoheliographic and spectroheliographic work and the latter the spectroscopic study of sun spots and of the solar rotation, was of great interest to me and I took every opportunity during my stay of being with Mr. Ellerman while he was making the daily photograph. Unfortunately, owing to Mr. Adams absence, there was no work done on spot spectra, nor any plates made for the measurement of the solar rotation. Even if he had been present, however, there were no sunspots of sufficient size to make successful spot spectra.

The solar definition on Mt. Wilson is at its best between one and two hours after sunrise and is also frequently good about an hour before sunset, but in the middle of the day, in general, somewhat unsteady. The form of coelostat house used, consisting of walls of canvas louvres painted white with inner movable canvas walls, seems to answer the purpose admirably as the temperature keeps quite cool inside the house and the free circulation of air prevents any stratification in the path of the beam. Thus any disturbance must be due principally to the air between coelostat and sun. This disturbance again is minimized by having the coelostat mirror at as high an elevation above the heated surface of the ground as practicable, and by having all the soil near the pier covered as far as possible with shrubs and trees to diminish radiation.

During the hours previously mentioned, the solar definition is very good indeed, much superior to any I have seen in Ottawa, so good indeed that the principal difficulty is not in the boiling or unsteadiness of the image, but is caused by change in figure of the mirrors due to the heating, by the sun's rays, of the silver surface. This change of figure is quite regular and appears principally on the coelostat mirror which becomes convex instead of plane and consequently lengthens the focus appreciably. The amount of increase depends upon the length of time the mirror has been exposed to the sun and also upon the freshness of the silver coating, but there seems to be a maximum increase of about 6 inches in 60 feet or nearly one per cent. An exposure of two or three minutes to the sun lengthens the focus by about an inch and, as, at the times of best definition, the angle of incidence on the coelostat mirror is large, the astigmatism thereby produced will affect the definition, the amount of course depending on the change in focus and the angle of incidence. Professor Hale has shown that the convexity is due to an actual bending of the mirror and has suggested as a remedy making the mirror nearly as thick as its diameter. The effect in practice is kept at a minimum by shading the mirror by a canvas screen, except during the times when a plate is being exposed or the image is being focussed, and also by blowing air on the surface by electric fans. The silvering of the mirrors is also frequently renewed, as a fresh coating absorbs much less heat than one which has become oxidized or tarnished. The change of focus during an exposure on the spectroheliograph, which may last for two or three minutes or in some cases with iron and hydrogen lines considerably longer, is compensated for as much as possible by setting the slit midway between the focus at the beginning and the estimated position of focus at the end.

The process of making a set of photographs is as follows. The coelostat house proper is rolled back on its wheels, its roof moving over the roof of the telescope house, until the coelostat mirror is fully uncovered to the sun. The coelostat and secondary mirrors are uncovered and placed in such position as to send a full beam to the concave mirror situated 100 feet south, which is then uncovered and the image focussed on the photoheliograph shutter, the concave mirror being moved backwards and forwards on a track by an assistant. The coelostat mirror is shaded and a plate placed behind the shutter, which consists of a narrow adjustable slit in a thin piece of board. The mirror is uncovered and, after the focus has been again examined, the concave is moved the correct distance to bring the focal plane on the sensitive surface and is diaphragmed to about 3 inches. The release of the shutter allows a spring to draw the narrow slit rapidly across the plate. Process plates are used on account of their greater contact.

The whole photoheliograph is moved out of the way and the sun's image is refocussed on the slit of the spectroheliograph. This instrument is of a very ingenious and yet simple design and works to perfection. In essence, it consists of a slit spectrograph of two prisms, the deviation being made 180° by means of an adjustable mirror. In place of the observing telescope is a second slit in the focal plane of the camera lens, and by moving the mirror any line of the spectrum may be thrown on this slit. The sun's image is focussed on the first slit and a plate placed almost in contact with the second slit. The plate and the solar image are stationary while the spectroscope is moved smoothly and uniformly past them. Thus, as any width of any line may be transmitted through the second slit, the solar image is reproduced on the plate in the light of the particular element calcium, hydrogen, or iron, which is set on the second slit. The greater part of the weight of the moving parts is counterbalanced by mercury floatation, while the balance of the thrust is taken by steel balls running in grooves. A screw motion driven by an electric motor moves the carriage containing slits, prisms, mirror and lenses smoothly and uniformly at any desired rate across the sun's image. For the calcium line about 1½ minutes exposure is required, for iron $\lambda 4045$ and hydrogen H_δ about 3 times as long.

A plate is taken for orientation by making successive exposures on the same plate, the solar image being allowed to drift 30 to 40 seconds between exposures. The second slit is then set on the centre of the H line, this being effected by using the electric arc which gives the H and K lines very strongly. Two plates are made of this region, one of iron $\lambda 4045$ and one of H_δ, $\lambda 4102$. This series of exposures is repeated on every morning and evening that the conditions permit of satisfactory results.

The spectrograph for making spot spectra, and for making adjacent spectra of opposite limbs of the sun for determination of the solar rotation, is of the Littrow form, one lens of 18 feet focal length acting as both collimator and camera, the plane grating of 4 inches aperture being so inclined as to diffract the light back upon its own path to the camera, which is placed 6 inches above the slit. The instrument is attached to the ceiling above the spectroheliograph and the sun's image can be thrown on the slit by simply tilting the concave. The spot spectrum is made through a diaphragm in front of the slit and the spectrum of the photosphere through a second diaphragm, which places a strip of solar spectrum on each side of the spot spectrum. Considerable linear dispersion is available with the focal length of 18 feet, but Professor Hale thinks it advisable to increase the focal length to 25 or 30 feet in order to get full photographic resolution.

The same spectrograph is used for obtaining the velocity of the sun's limbs to determine the rotation period. The opposite extremes of a solar diameter are reflected to adjacent positions on the slit by a pair of reflecting prisms at each side, and the double shift of each line from the advancing and retreating edge is measured. The limbs at the sun's equator are brought into juxtaposition on the slit by rotating this reflecting arrangement only, so that the edge of the limb is generally not tangent to, but inclined across the slit. A method by which not only the reflecting arrangement but the whole spectrograph could be rotated would be preferable, and also a means of obtaining accurately opposite limbs at the extremities of any desired parallel of latitude. As Mr. Adams, who had done most of the work with this instrument, was away, I was unable to obtain any information as to his success and the probable accuracy of the determination.

Mr. Ellerman very kindly showed me a large number of plates of spot spectra, and of those made with the spectroheliograph and photoheliograph, all of which were very interesting and instructive. The plates of spot spectra were very good, widened and weakened lines being well shown. A comparison of spectroheliograph plates taken at the same time in hydrogen and calcium light, and also in those taken at intervals of a few hours, proved very interesting. The comparison is very easily made in the stereo-comparator, which depends upon the principles of binocular vision for exhibiting slight and faint differences between two plates. On two plates of the calcium flocculi on the sun's surface, taken about ten hours apart, the globular surface of the sun and the different elevations of the calcium clouds were well shown, while, in a single eyepiece, arranged so that the two images could be seen in as rapid succession as desired, was substituted for the binocular arrangement in the comparator the forms of the flocculi taken at the same time in calcium, iron, and hydrogen could be readily compared.

After the Snow telescope house, the most interesting place on the mountain is the laboratory, which is a substantial cement building well equipped for spectrographic research. The spectroscope or spectrograph used is another grating instrument of the Littrow form, and is placed along an inner wall pointing towards the centre of an annular pier about 10 feet in diameter. Around this annulus are placed different means for producing emission spectra such as the induction coil with variable capacity and self induction, an accessory to the coil being an air pump for exhausting tubes; an ordinary arc lamp for obtaining metallic spectra; a synchronous arc for obtaining the alternating arc at any desired phase; Crew's rotating arc and a chamber for obtaining the arc under high pressure. Each one of these sources is directed towards a mirror at the centre of the annulus, which reflects the light to the spectroscope slit, while sunlight may be obtained from a heliostat outside. The usefulness of such an arrangement for spectroscopic investigation is self-evident as one can, in a moment, turn from spark to enhanced spark, to ordinary, synchronous, or rotating arc, to arc under pressure, or to sunlight without having to, as under ordinary conditions, erect each one of these in the optical axis of the spectroscope.

In the spectroscopic laboratory are also very complete dark and enlarging rooms for all branches of photographic work, and two or three small rooms in one of which is the stereo-comparator, and in another a machine for measuring spectra, for, although the measuring and computing is to be done in Pasadena, there is always demand in experimental work for preliminary or tentative measurements of plates.

The arrangement at Mt. Wilson as regards living is very simple, and, although it is objectionable as separating the observers from their families for the greater part of the time, has advantages on the score of cheapness. The colony there differs from that at Mt. Hamilton, which is essentially complete in itself, having houses, a school and forming a community with the director as chief, in being entirely of a bachelor character, the families of the observers living at Pasadena. This seems in many respects unsatisfactory, as the trip up and down the mountain is quite an undertaking, occupying about five hours in the ascent and three to four hours in the descent, but it is probably the best plan that can be evolved at present.

I can not close this description of the Solar observatory without expressing my gratitude to Professor Hale and every member of his staff whom I met, for their uniform kindness and willingness to assist me in every particular possible during my visit. It is not necessary to speak of the enthusiasm with which the work is carried on, nor of the esteem and respect each member entertains for the director, who, with his highly specialized qualifications for the work in hand, is at the same time most widely read and broad in his interests. He impressed me not only as one of the most able men I have ever met in his specialty, but he is also charming for his geniality and kindliness, while his method for the management of the great work he has undertaken can not be excelled. The few days spent at Pasadena and on the summit were not only very pleasant ones, but the insight obtained into the methods of carrying on the work will be of the greatest use to us when we commence our own work in solar research.

Lowell Observatory.

Flagstaff, which is a place of some 2,000 inhabitants on the elevated plateau of Arizona, was reached on Sunday, September 9th, about 3 p.m. The observatory is situated on a hill half a mile to the west of the town, about 300 feet high, the altitude of the observatory being about 7,200 feet. I walked up to it and had a short talk with Mr. Slipher, who has charge of the spectrographic work, and arranged to spend the following day and night at the observatory. He was very kind in showing me the spectra he has obtained, in explaining to me his method of working and the class of work he is at present engaged in. The quality of his star spectra does not differ essentially from those obtained with our Brashear spectroscope, his short exposure ones being slightly less sharp and his long exposure ones sharper than ours. In the Lowell spectrograph the flexure is probably much less and the temperature control closer than in our instrument, and this will explain the better quality of spectrum obtained of the fainter stars.

He is considering the advisability of obtaining a new single prism instrument for stars of the first type with broad lines. High dispersion is worse than useless for such stars, as it makes the already broad lines so wide and diffuse and so weakens the contrast as to render them hardly recognizable, let alone measurable. For this purpose he wishes to obtain a perfectly homogeneous prism with as slight absorption as possible, especially in the violet, in order to obtain the largest possible number of the hydrogen series. He showed me many peculiar spectra of the first type in some of which even the H lines were barely recognizable. Some of these showed traces of a second spectrum, and one or two were very complex and peculiar. He seems to be getting excellent results, but like every one else engaged in radial velocity work is far behind in his measurement and reduction. He uses the method of reduction employed by Frost and Adams, which is practically the same as that employed here until very recently, while his measurements are made on a Gaertner microscope essentially the same as that employed at the Yerkes except that it has a position circle on the microscope head to determine the inclination of the lines. This position circle is used for determining the rotation period of the planets where, if the slit is set parallel to the equator, the approach of one limb and the recession of the other will cause the lines to be inclined. From a measurement of this inclination the velocity and consequently the rotation period can be obtained.

Much work on the spectra of the planets has been done following out the well known purpose of the observatory and some beautiful planetary spectra have been secured. I was much interested in a magnificent spectrum of Saturn and his rings, in which the different angular velocity of the inner and outer parts of the ring first demonstrated by Keeler at Allegheny was very clearly shown.

Mr. Lampland, who has made such success in the photography of the planets especially of Mars, was also very kind in showing me some fine examples of his work. Any one with experience in that line knows that the photographing of such objects is a very difficult matter owing to the amount of magnification of the image in the prime focus necessary and to the corresponding magnification of the inevitable atmospheric tremor, and that it is only under exceptional conditions of steadiness that any success is possible. His success is possibly partly due to his perseverance and to exposing in rapid succession, thus taking advantage of the frequently very short intervals of really first class seeing.

On Monday night I had the privilege of being with Messrs. Slipher and Lampland at work. The air at Flagstaff owing to the dryness and high altitude is exceptionally transparent and the naked eye view of the heavens is very brilliant. The quality of the seeing, however, was not to my mind equal to that on Mt. Hamilton, and this I judge principally by the estimate formed by the observers themselves of the steadiness using the same scale, calling perfect seeing 5, seeing 3 at the Lick was much steadier than seeing 3 at the Lowell observatory. The same thing was true in regard to the blue image used in stellar spectroscopy. Such image seemed much larger and more unsteady at the Lowell than at the Lick observatory. This may be due in part at any rate to a difference in the performance of the correcting lenses. It was indeed the great difference in the character of this blue image as seen at the different observatories that led me to investigate the character of the image given by correcting lenses.

The Yerkes Observatory.

Leaving Flagstaff on Tuesday, September 11, via the Santa Fe system, Chicago should have been reached on Thursday, but owing to a derailment ahead of the train we were nearly twenty-four hours late and I was consequently a day later in reaching Williams Bay than I had anticipated. However, Professor Barnard, who had most kindly invited me to stay at his house during my visit, met me at the station and took me up the lake to his house which is very prettily situated close to the observatory and overlooking lake Geneva. I was very kindly received by Mrs. Barnard, and most hospitably entertained during my stay. After dinner Professor Barnard took me to the observatory and introduced me to the members of the staff, and I received here from all, the same kindly treatment as was accorded me wherever I visited.

The Yerkes observatory is prettily situated on lake Geneva, a well known Chicago summer resort, about 90 miles from the city. It is a handsome building of white terra cotta and forms a very effective picture. The grounds, however, are entirely uncared for, and the appearance would be much improved by suitable landscape gardening. The building is one storey, of considerable length, with the large 90-foot dome at one end and two of about 30 feet diameter each at the other. The offices, library, &c., are on both sides of the central corridor, connecting the large with the two smaller domes. In the basement below are instrument and optical shops, the spectroscopic laboratory, &c.

In the 90-foot dome is the 40-inch refractor with its various attachments and with every convenience for facilitating as far as possible the handling of this massive instrument. At the Lick observatory the floor and dome are moved by water power, but here they are actuated by electric motors, whose controllers are placed close to the south side of the pier. By these means the movements are made quite rapidly and easily and are under complete control. The telescope itself, though much heavier than the 36-inch, can be moved from the eye end by the hand, though not very easily, and can be clamped and moved in slow motion by hand wheels, as in smaller telescopes. However, electric motors in the clock room inside the pier allow the telescope to be turned rapidly in right ascension and declination. Four ropes running vertically at the south side of the column serve to control these motors and by pulling down on one or other, move the telescope quickly east or west around the polar axis and north or south around the declination axis. Thus the telescope can be quickly and easily moved to any desired position or reversed. Besides these motors, another automatically winds the clock when run down, and two small ones placed on the tube and declination axis respectively, which gear into the slow motion screws in declination and right ascension, give a very slow motion in either co-ordinate by simply turning a switch at the eye end.

The 40-inch, unlike the Lick, is used both day and night, in the day time for solar work, photoheliograph and spectroheliograph pictures, and at night for stellar observations. The programme is arranged to have the equatorial in use every fine night from dark to dawn. Both here and at the Lick observatory the work is so divided that, as a rule, one person does not use the instrument for a longer period than one-half the night, being relieved at midnight by a second man. This is an admirable plan, where it can be followed, as it allows the telescope to be worked to its full capacity without overtaxing the observer's strength.

The 40-inch is used on two nights a week for spectrographic (radial velocity) work, two nights for Burnham's double star work, one and one-half nights for general micrometric work by Barnard, and the other one and one-half for photometric work and for making photographs to be used in the determination of stellar parallax. The spectrograph used has been fully described by Frost in the Astrophysical Journal, and is especially distinguished for its very massive and rigid construction, and for the large size of its prisms. It is only with telescopes so large and heavy as the Yerkes that such a heavy instrument could be used and some of its parts are to my notion unnecessarily heavy. Part of the extra weight is necessary on account of the large prisms, which are of sufficient size to transmit a pencil of 51^{mm} aperture. As recounted by Prof. Frost in his description of the instrument, considerable difficulty was experienced in obtaining homogeneous prisms and even those now in use, although a great improvement on the first ones, are not entirely free from action on the light and the resulting definition is not as good with full aperture as when a diaphragm of half the aperture is inserted. Professor Frost is of the opinion that, if he were making a new spectrograph, he would use considerably smaller prisms to transmit a pencil of about 30^{mm} diameter. The advantage of the large prisms lies in the wider slit that may be used for the same purity of spectrum, an advantage that, in the case of telescopes of such great focal length as the Yerkes, should not lightly be foregone.

The spectrograph, as described, was only adapted to use three prisms, but has since that date been modified to permit the use of a single prism, and I believe most of the work now done is with this dispersion. Prof. Frost tells me that perceptible flexure is entirely absent in the Bruce instrument, and that I can readily believe owing to its massive construction which is in this respect an advantage. Also, owing to the great weight of the spectroheliograph the change from one instrument to another is accomplished with little change in the balancing, but when the change from either of these attachments to the micrometer or other visual appliance is required, or vice versa, some 500 pounds of counter weights have to be handled, making the operation somewhat laborious.

The spectrograph is enclosed within a double walled aluminum case and is heated by coils of German silver. The current is turned on and off these coils by hand as required. The case is not fitted with an automatic arrangement for controlling the temperature, as there are always two observers in the room when in use, and one can attend to the temperature while the other guides. But in my opinion a good automatic control is preferable, as likely to maintain the temperature much more constant, which is extremely important for accurate results. The image given by the 40-inch with correcting lens for photographic light does not seem nearly so good as is obtained at the Lick. There is much diffuse light around the central image and this is probably the reason why the exposure times required at Yerkes are about double those at Lick. The difficulty probably lies in the correcting lens as the object glass visually gives excellent definition.

Professor Frost has two or three different lines of work with the spectrograph under way. The chief one is the determination of the velocities of those Orion type stars within the limits of the instrument, which is about the fifth mag. with a dispersion of 3 prisms and about the seventh with a single prism. He is also engaged in determining the velocity curves and comparing them with the light curves of some Algol variables and finally has a list of Hydrogen or first type stars ready to be observed. But like every other worker in the line of sight, he has accumulated a large number of plates ahead of the measurement and reduction, and complains of the impossibility of getting assistance in this work. He is also endeavouring to obtain velocity curves for some of the spectroscopic binaries discovered at Yerkes.

During the period of my visit, he was engaged on the orbit of β Cephei the spectroscopic binary of a period of only about four hours, which has since been discussed by him in the Astrophysical Journal. He very kindly showed me many interesting spectrograms he had obtained and was most kind and helpful in many ways. One of the most pleasant parts of my trip was the privilege of talking over with him and others engaged in the same line of work as myself, the small details of the work and in comparing experiences, and many helpful ideas were obtained in this way.

I spent one evening with him in the dome while he was making spectrograms, and saw the ease with which by the slow motion motors, the large telescope is guided. The motion with these motors is so gradual and uniform that no vibration is set up and the guiding can be very accurately done. I found it difficult, owing to the amount of diffuse light around the image to guide, but have no doubt a little experience would soon render it easier. The observer and the engineer in charge of the 40-inch, take turns at the guiding, while the other attends to the rising floor and dome motors and looks after the temperature of the outer case.

Professor Burnham, unfortunately, I did not meet, as he only comes to the observatory on Wednesdays and Thursdays, and uses the telescope on these two nights in micrometer measure of double stars in preparation for his great general catalogue of double stars, soon to be issued by the Carnegie Institution of Washington. Professor Frost told me that he was a wonderful observer, making as many as 60 measures in a night.

Professor Barnard uses the 40-inch on one and a half nights per week in micrometric measurements of the positions of the satellites of Jupiter, Saturn, Uranus and Neptune, in a triangulation of the principal star clusters and in several smaller miscellaneous pieces of work. I was with him a couple of nights while he was observing with the 40-inch, and I could not help but admire the systematic way in which he set about his work, the quickness with which the measures were made and recorded, and the way in which the instrument was handled to obtain the maximum amount of work. He took the greatest pleasure in showing me objects which would exhibit the great power of the object glass, but owing to the invariably poor seeing we were unable to get a fair test of its capabilities.

Mr. Parkhurst, during the time of my visit, was measuring the brightness of the satellites of Saturn, on the 40-inch, with one of the Harvard type of comparison wedge photometers, in which an artificial star is brought to equal intensity with the real star by means of a photographic wedge. The 40-inch is used one night a week for photometric work by Mr. Parkhurst, who also uses the 24-inch reflector and the 12-inch refractor for the same purpose.

Mr. Jordan, for half a night per week, makes photographs of a narrow zone, near the equator on plates 8 x 10 in size, guiding by means of a double slide plate carrier and a guiding eyepiece at the edge of the field. These plates which are exposed for about an hour each to get stars of the 12th or 13th mag. are sent to Kapteyn, who is having them measured in accordance with a regular scheme for the determination of stellar parallax.

Mr. Fox, who had just returned from Potsdam, after a year spent with Hartmann, has charge of the solar work at the Yerkes, and makes a daily photo and spectroheliogram of the sun's surface. He is at present measuring the spectroheliograph plates in an attempt to determine the period of the solar rotation. The position of the spots and flocculi are determined by the projection of the negative on a globe ruled in degrees. The negative is first reduced to about 2 inches in diameter, and this is strongly illuminated by an arc lamp and condensing lens and its image is projected on the globe by an objective of 12-inch diameter, and the same focus as the 40-inch objective. In this way the photograph of the sun is projected upon the globe in the same way as if it were the actual image, and its pole can be placed at the corresponding position of the sun's pole and the position of spots or flocculi estimated to tenths of degrees. It is, however, questionable whether as much accuracy can be obtained by this method as by measuring in polar coordinates and reducing, but it is certain that the former takes only a small fraction of the time.

The spectroheliograph works on a similar principle to that at Mount Wilson, but, owing to the fact that it is attached to a moving telescope, it cannot be used in exactly the same way, by moving the instrument as a whole across the fixed solar image and in front of a fixed photographic plate. The spectroheliograph, which is a heavy piece of apparatus, weighing some 700 pounds, is attached rigidly to the telescope tube, and after the instrument is adjusted, the telescope clock carrying tube and spectroheliograph at the solar rate, the sun's image is made to drift across the slit, which is set east and west, by the slow motion electric motor in declination. A small shaft coming down the tube communicates a similar motion to the sliding plate holder and plate, which is moved at the same rate across the second slit as the sun moves across the first slit. The instrument, though from its nature not so simple and efficient as the Mt. Wilson spectroheliograph, gives excellent results. The photoheliograph is simply a plate holder, having in front a sliding shutter containing a narrow slit placed so that the plate is in the prime focus of the 40-inch. Process plates are used, and the objective is diaphragmed to about 2½ inches aperture, the exposure being given by a slit about 1/20-inch wide, moved across the plate by two strong springs. Here also very good definition is secured, though the colour curve of the 40-inch objective at the part of the spectrum for which process plates are sensitive is very steep, and the difference in focus for the extreme limits to which the plate is sensitive must be in the neighbourhood of 3 inches. However, stopping down the objective must so diminish the angle of the cones of light that the resulting aberration must be within the limits of visibility so far as photographic resolution is concerned; indeed a simple calculation will show that the lateral aberration for a longitudinal aberration of 1½ inches would be about 1/200-inch, and this is not of much account in ordinary solar definition. As, however, only the extreme limits to which the plate is sensitive, $\lambda 4600$ to $\lambda 4000$, would have that amount of aberration, and as the sensitiveness of the plate at these limits is much less than at the centre, the resulting aberration would probably not exceed one-half of that stated above, and would certainly not be in evidence in solar definition.

Considerable time is required to change from spectrograph or micrometer to spectroheliograph, and the whole operation of making the change and exposing the plates occupies about an hour. I was with Mr. Fox while this operation was being carried through, and was much interested in watching the various steps of the process. The changing from one attachment to another is much facilitated by the special carriages holding each instrument which can be wheeled up to the telescope, placed in a certain hour angle and declination with the rising floor in its highest position, and readily attached to the tube. Every device possible for minimizing the labour of changing and adjusting has been adopted, rendering the process quite safe and easy. After the change has been made and the tube rebalanced, the declination slow motion motor is attached to the plate holder carriage by a shaft running down the tube, which is easily connected to another shaft on the spectroheliograph, which by suitable gearing drives the plate at the correct speed.

Mr. Fox kindly showed me many spectroheliograph plates, some of which were not excelled by any on Mt. Wilson, but taken as a whole the latter are probably superior. Some very interesting examples of calcium flocculi were seen, and the method of obtaining the solar rotation period from some of the more persistent of these flocculi, which maintain their form and position for a longer time than sun spots, was explained. Mr. Fox also gave me an account of some of his work with Dr. Hartmann, of whom he speaks in the highest terms, and I was particularly interested when he spoke of Hartmann's new spectrocomparator, and the new type of spectrograph camera lens.

The two-foot reflector with which Ritchey made his beautiful nebula pictures is in the east dome and is at present being used chiefly for photographic photometry by Parkhurst, the determination of stellar light intensity by the diameter of the photographed image. Parkhurst is obtaining excellent results by this method, but it seems to be applicable chiefly to reflector images. He is at present working on a new method of photometry by the measurement of the density of extra-focal discs. In this method a photographic doublet objective is used and the plate moved a few millimetres out of focus. The result is that the star light is spread out into a disc and the density of this disc will depend on its diameter, the length of exposure, and the brightness of the star. Here, however, there may be difficulties as regards the behaviour of the photographic plate to light of different intensity. The relation between the light action and the resulting capacity is not a simple one, and what is worse for this case, is not even a constant one, so that before satisfactory results can be obtained considerable photographic investigation must be carefully carried out. Mr. Parkhurst has a Hartmann microphotometer for measuring the opacities of these discs, but owing to faulty centering of the Luminer Brodhum cube there is overlapping of the images and consequent loss of accuracy in its use.

I had a long talk with Prof. Barnard over the stellar photographic lens question, and I was also much interested in seeing some of his magnificent results with the Bruce telescope, obtained at Mt. Wilson last year. As pictures of the Milky Way, they are unexcelled and he is now hoping to get satisfactory heliogravures made for reproduction. In the Bruce telescope he has found a very satisfactory instrument, and one very convenient in use. It consists of three photographic cameras of 10-inch, 6-inch and 2½-inch aperture, respectively, attached to a 5-inch visual guiding telescope and equatorially mounted on a bent column to allow of passing the meridian at high altitudes without reversing. The field given by his objectives is not as large as that given by our Brashear 8-inch, but the definition at the centre is perhaps a little better. I had taken with me three negatives by our 8-inch lens of an hour's exposure each, with foci differing by $\frac{1}{2}^{mm}$, to see whether Barnard was still of the opinion he had previously expressed, viz.: that I had been using the lens with the plate too far within the focus. However, when he saw the negatives, he admitted that the focus was correct, but that the large star images at the centre were due to a penumbra around the image that only showed with fairly bright stars, with faint stars it was not visible, and with those very bright it had become fully exposed, and thus much increased the diameter of the image. Such a penumbra is not visible in the images given by his objectives and the extra wide field in ours is probably obtained at the expense of residual chromatic aberration. In talking with Dr. Brashear and Mr. McDowell on this question, they stated they were certain it was not spherical aberration and they could only explain it as due to chromatic effect. I left the plates with them to show to Hastings to try and determine the cause.

Prof. Barnard thinks that this penumbra should be got rid of, even at the expense of diminishing the field, but I can not say that I entirely agree with him. It seems to me that it depends upon the purpose for which the lens is to be used. For pictorial work and for star positions the wide field seems to be an advantage, though the penumbra from the spreading of the light will cause the loss of the fainter stars. Hence if the purpose is to get a limited field of the faintest possible objects, then this resultant aberration should be cured, but if it can only be cured with sacrifice of field, it seems to be preferable for most purposes to let it remain as it is, especially as the seeing here is rarely transparent or steady enough to attempt very faint objects.

The Bruce telescope is mounted in a small building in front of the observatory, and quite close to Professor Barnard's house, and every fine night that this indefatigable worker is not using the 40-inch, he is at work with the Bruce, photographing parts of the sky where he has not as yet obtained photographs which he deems wholly satisfactory. Another branch of photographic activity he follows energetically whenever opportunity offers, is the photographing of comets, and he has obtained some beautiful negatives of the more conspicuous of the recent comets. He suggested this as a useful application of our photographic doublet, and advised it being mounted separately with a guiding telescope in a similar manner to the Bruce.

I also had a talk with Mr. Wallace, the photographer at Yerkes, who is carrying on two or three lines of photographic investigation. The most important of these is the relation of the temperature during exposure on the sensitiveness of the photographic film. He was led to this investigation by the experience of Professor Frost in spectrographic work, who found that the exposure time in zero weather was much less, nearly 50 per cent, than in summer, although possibly part of this may be due to the greater transparency of the air in winter. Wallace claims to have definitely proved that plates are much more sensitive to light action at a low than at a high temperature. This seems in direct contradiction to the general law of increase of chemical action with increase of temperature, which of course holds when development takes place. So far as Wallace's experiments have gone, however, they seem to substantiate his theory, and he was only waiting for winter weather to finally complete his tests.

He is much interested in the tests of colour sensitiveness of photographic plates, and is an ardent advocate for this purpose of the transmission grating, as opposed to the prism, on account of the normal spectrum given by the former. Indeed he is so strong a believer in the advantage to be gained in accuracy and the standardization of results by the use of the former that he is making, and presenting to everyone likely to use such an article, replicas of one of Rowland's plane gratings, which give very fine spectra.

He has devised a very simple spectrograph for testing plates in which this grating is used and in which at any time a plate may be tested without any setting up or adjusting of apparatus. His laboratory is well supplied with sensitometers, photometers and other appliances for investigations in photography, and such work is a very useful adjunct of a modern observatory, in which a large part of the work depends upon the application of photography.

The workshop and optical shops in the basement of the observatory are well equipped for instrument work, but are evidently not so much used since the departure of Professor Ritchey for Pasadena. The spectroscopic laboratory, also in the basement, is well suited for general spectroscopic investigations, although naturally not so well arranged and equipped as the one on Mt. Wilson, which is a further development by Prof. Hale, and a model of convenience.

The spirit of the staff of the Yerkes observatory, like that of Mt. Hamilton and Mt. Wilson, is one of enthusiastic devotion to their chosen profession. Every member works enthusiastically along his own line of research and there seems to be a unity of interest among all, which is a tribute to the kindliness and tact of the director. The three large observatories I visited, the Lick, Solar and Yerkes, seem alike fortunate in their directors, as well as in the personnel of their staffs, and their success and the amount and quality of work done is in a large measure due to the harmony and good feeling which exist in all three.

My thanks are due to every member of the staff at Yerkes for their efforts to make my visit a pleasant and profitable one, but especially to the director and to Professor Barnard. To Professor Frost for the assistance and advice in spectrographic matters and to the insight into their methods of work he so willingly afforded me, and to Professor and Mrs. Barnard for their hospitality and efforts to make my visit a pleasant one.

Allegheny Observatory.

Leaving Yerkes on Wednesday morning, September 19, the afternoon was spent in Chicago, and I left in the evening for Pittsburg, reaching there the next morning. I immediately went to the Brashear instrument works and renewed my acquaintance with Dr. Brashear with the greatest pleasure. The morning was profitably spent in discussing various optical problems of interest with him and Mr. McDowell, especially those relating to the field of the photographic doublet they made for us and the optical parts of our new spectrograph. I saw the prisms and the new single material camera lens and pointed out to Mr. McDowell the necessity for enlarging the rear element to prevent cutting off part of the pencil, which contention has since been justified. I spent considerable time during my stay in Allegheny in their shop, as it was considerably more interesting than the observatory, which has as yet hardly made more than a start at astronomical work. They were not at the time of my visit engaged in any large optical work, but were expecting orders for several large objectives and mirrors. Dr. Brashear, whom I found the same whole-hearted, kindly gentleman and his good wife, did their utmost to make my visit to Allegheny a pleasant one. Dr. Brashear took me up to the observatory and introduced me to the director, Dr. Schlesinger and to Dr. Curtiss, and with them we inspected the various interesting features of the observatory. Since my previous visit to Allegheny, the Keeler Memorial telescope has been completed and mounted, and spectrographic work is now being carried on by Dr. Curtiss. The whole telescope, mirror and mounting, was made by the Brashear Company, the design of the mounting being due to Wadsworth, and is, so far as I can learn, a very satisfactory instrument. It is arranged in the cassegrainian form for spectrographic work, the spectrograph being placed below the mirror. The spectrograph is a single prism instrument of Curtiss' design, constructed by Brashear, the form being somewhat similar to the remounted Mills, except that it is of a triangular instead of oblong form, with angles of approximately 120°, 30° and 30°, the prism being near the obtuse angle, and the two adjacent sides of the box which, in this case, is of brass, instead of steel, form the collimator and camera tubes respectively. The instrument is attached to the reflector similarly to the new Mills at two points of support, one near the centre of gravity of this box consisting of a pivoted axis passing through the box, its ends being moveable in guides for placing the slit in the star focus, the other consisting of a cylindrical bearing concentric with and forming the slit end of the collimator tube moving in a collar attached to the same truss which carries the guides above mentioned. Thus the spectrograph proper is self-contained and held without any constraint by its supports. This form of instrument should be the least liable to flexure difficulties, but how it behaves in that respect I do not know. It had only been in operation a short time, and owing to their having no measuring microscope, no plates had been measured, so no idea of its effectiveness and accuracy could be obtained.

The form of mounting there adopted, which admits of changing the position of the slit by the movement of the whole spectrograph rather than of the collimator tube only, is necessary for reflectors owing to the rapidly changing positions of the star focus with change of temperature of the mirrors, this frequently requiring the focus to be changed during an exposure. If the collimator tube only were moved there would be great danger of some systematic displacement of the lines, but this cannot occur in the movement of the instrument as a whole.

The method of attaching the spectrograph to the reflector quite close to the mirror is convenient, on account of the slight change of position necessary for the observer in guiding. It makes no difference, of course, in the flexure, which depends only on the angular motion and not on the motion of translation of the spectrograph. The spectrograph, when in use, has a close-fitting outside wooden case, lined with felt, and the spectrograph itself is covered with felt on the outside to smooth down irregular temperature changes. German silver wire is coiled around on the felt on the inside of the case, and the current is turned on and off these coils by an electric contact thermometer in conjunction with a relay. Dr. Curtiss informed me that he preferred to have the heating coils uniformly distributed over the case rather than trust to convection currents to distribute the heat from coils in one part of the case, and in this contention our own experience with the heating of the new spectrograph bears him out.

The dome is arranged to be turned by electric motor, and this much diminishes the labour of the observer, as the hand motion does not work very easily. Besides this reflector, only the 13-inch refractor belonging to the original Allegheny observatory is mounted. While I was there the steel work of the dome for the 30-inch refractor was being erected. Dr. Brashear, to whom the new Allegheny observatory owes its existence, as it is by his efforts and influence that the money was obtained to build and equip it, had just secured sufficient subscriptions to complete the dome and equatorial mounting for the 30-inch refractor, and had hoped to have it in operation in 1906. When, however, they started to polish and figure the crown and flint discs, which had been ground some time previously, it was found that the glass was not sufficiently homogeneous to make a perfect objective, and they were obliged to reject them after putting $5,000 worth of work on them. Besides this severe loss to the Brashear Company, it necessitated delay until other discs could be obtained, as frequently a long time is required to obtain perfect discs of so large a diameter as 30 inches.

Wadsworth's plans for the new Allegheny observatory were very ambitious, and lay chiefly along the line of solar research, which he claimed, and rightly, to be the work most suited to the smoky atmosphere of Allegheny county. It is also, I believe, the purpose of Dr. Schlesinger to undertake solar investigations as soon as the necessary equipment is obtained. In the meantime radial velocity work with the Keeler Memorial and the one prism spectrograph is being carried on as continuously as the weather will permit.

In Drs. Schlesinger and Curtiss, the observatory possesses two able men, and should maintain the high reputation already attained under Langley and Keeler. The kindness extended me by these two gentlemen made my visit to the observatory a very pleasant one, and the opportunity of discussing with Dr. Curtiss the spectrographic problems we had previously corresponded about, proved very helpful. I cannot, however, close this short description of my visit to Allegheny without expressing my appreciation of the kindness of Dr. Brashear and his family. For encouragement and helpfulness in the commencement of my astronomical work, I, like many other astronomers, already owed him more than it is possible to repay, but he always seems to be glad to add to such a debt, and my present visit was no exception to the rule.

Washington.

In Washington, which I reached on Sunday afternoon, September 23, I had three places to visit, the Bureau of Standards, the Naval observatory and the instrumental branch of the Coast and Geodetic Survey, and as my time was getting short, my visit to each was necessarily hurried.

The Bureau of Standards I found a most interesting place, and well worthy of a much longer visit than I could afford. As it is a comparatively new institution, I found it equipped with the very latest apparatus for measurements of the highest precision, installed in buildings especially adapted for their particular purposes.

The director of the bureau, Dr. S. W. Stratton, has succeeded in obtaining a most capable staff of physicists to carry on the work of the institution, and it promises to play a most important part in the scientific and technical activities of the United States. Its main purpose is, I presume, in accordance with its name, to furnish standard measurements of all physical quantities whenever required, either for scientific or commercial purposes, but with that, if we are to judge by the bulletin issued, is combined much original investigation of the highest rank.

I found on reaching the Bureau on Monday morning that the director, to whom I had a letter of introduction from Dr. Brashear, was not in the building, and I was conducted to Dr. Rosa, chief of the electrical branch, who, after showing and explaining the very complete electrical equipment for the measurement of resistance, capacity, self-induction, current, potential, &c., introduced me to Mr. Fischer, who has charge of the linear measurements and the standards of length.

This branch of the work, in which I was particularly interested from its application in the scales and screws of astronomical measuring engines, was thoroughly shown to me by Mr. Fischer who took great pains in making me acquainted with everything of interest. The various comparators employed for standardizing scales with the auxiliary apparatus for ensuring the highest accuracy of measurement were first shown, and these were followed by the unlocking of the vault containing the primary standards of length of the United States. Mr. Fischer's description and short history of each of these standards was very interesting, and one could easily spend a day at this branch of the Bureau's work alone. The underground passage in which steel tapes are standardized also possesses much of interest on account of its application to our surveying work.

The engineering department and the machine shop, which is completely equipped with separately motor-driven machine tools and where a number of machinists are continually employed, was next visited. Another interesting branch of the work was the photometric laboratory, where all the most recent apparatus for the measurement of light intensities is installed, and where much valuable research on photometric problems has been undertaken.

The spectroscopic laboratories under Drs. Nutting and Coblentz were also of much interest to me. Dr. Nutting, who has done considerable work on line structure, kindly showed me the complex nature of some of the mercury lines by an echelon spectroscope. A useful wrinkle obtained here, was the employment of a special transformer, using ordinary alternating current for spark work, rather than an induction coil. Dr. Coblentz also showed me the spectroscope and appliances used in his work on infra-red emission and absorption spectra.

There were many other interesting departments in the bureau which I had not time to see, but which would be well worth an extended visit.

The Naval Observatory.

The Naval observatory is situated in the same section of the city as the Bureau of Standards, and is only a short walk from the latter. The group of buildings comprising the observatory is situated in extensive and well kept grounds, and the white buildings with the green surroundings make a pleasing picture.

The acting superintendent introduced me to Professor Skinner, who has charge of the work done with the equatorial telescopes, and he showed me around the buildings, introducing me to the various officers. The most interesting parts to me after the equatorials, were the time system and the meridian circle work. The time system is not so complete as ours, and although they possess a Riefler sidereal clock, the means for the maintenance of constant temperature are primitive compared with the complete system installed by Mr. Stewart. However, they propose to move the standard clocks into a separate building, where presumably, a better system of temperature control will be installed. They have many ingenious arrangements for the comparison of clocks and chronometers, which is in the Naval observatory, a very important part of the work. All the chronometers of the navy are rated here, and there are always a large number of chronometers under regulation.

The meridian circle work is an important part of the observational work, and a great deal of useful work in that line has been done at Washington. The meridian circles are placed in separate buildings of galvanized iron with azimuth marks about 100 yards distant. A travelling-wire micrometer for the Warner and Swasey meridian circle, also made by Warner and Swasey, had just been received, but had not yet been attached to the instrument. It looked a very workmanlike micrometer, and had for the contact wheel, instead of the usual hard rubber, one of glass with inserted platinum strips for the contacts.

The twenty-six inch equatorial is placed in a separate building, which, besides the dome, contains two or three offices for the observers. The object-glass by Clark, was originally provided with a mounting by the same firm, but this has since been changed to one of Warner and Swasey's, which, like all their mountings, is very convenient and efficient. The equatorial room has a rising floor moved by hydraulic pressure, and this is a necessary and most useful adjunct to a refractor of over 18 or 20 inches aperture. The work done with this telescope is, so far as I know, wholly micrometric and consists chiefly in measurements of the positions of satellites of the planets, of the minor planets and of comets. The smaller equatorial in the main building is used in the same line of work.

I had an opportunity of observing on Monday night, the character of the image given by the 26-inch and of the quality of the seeing at Washington. At every observatory I visited I had examined the appearance of the image within and without focus as well as at the focus. Theory calls for the appearance of the central disc and rings to be nearly the same outside as inside the focus. This is not the case with the Ottawa instrument, where the appearances within and without focus are somewhat different. However, an examination of every telescope I saw, the 36-inch Lick, the 24-inch Lowell, the 40-inch Yerkes, the 26-inch Naval and the 18-inch Flower, gave appearances almost identical or at any rate quite similar to that seen at Ottawa. A single exception was the 12-inch Clark objective at Mt. Hamilton, whose figure, according to Professor Campbell, is almost absolutely perfect, and which gave almost identical appearances within and without focus. Whether the zonal differences of focus, which presumably are the cause of this dissimilar appearance of the extra focal images, are sufficiently great to affect the quality of the image at the focus (so far as regards visibility and separating power) is questionable, for each one of the objectives mentioned above is considered to be of the very first quality, and they all have separating power up to their theoretical limit. Every one of these except the 18-inch Flower and the 15-inch Ottawa, which are by Brashear, are of Clark's figuring. The Brashear objectives, however, are by no means inferior, as Professor Eric Doolittle has been able to resolve double stars even under the poor atmospheric conditions of Philadelphia, of a separation considerably within the theoretical limit for an objective of 18 inches aperture. This shows that the figure must be so nearly perfect that the light is concentrated within the central disc, and into the central part of this disc in a manner equal to that called for by theory, and this would not be the case if the outstanding zonal aberrations were of any appreciable magnitude.

In this connection it may be of interest to recount an experience of Dr. Brashear in this line, which he told me along with a wealth of other experiences and incidents in connection with optical work. This was in connection with an objective of moderate aperture, I think about 6-inch, which he made for a certain purpose, and which required it to be of as perfect a figure as possible. The objective was completed and tested by Dr. Brashear and Mr. McDowell, and sent to the purchaser. The sending of course meant, as every one who has had an experience with Dr. Brashear's methods knows, that the objective was as good as could be made. However, a notification was shortly received that the objective would not answer, that the appearance of the extra focal images was not the same, and that the figure was therefore not perfect. To satisfy both themselves and the purchaser, they therefore figured a second objective of the same size as the first, so that this condition of similar extra focal images was satisfied, and sent this one to the purchaser, asking that the two be carefully compared and the best one kept. Shortly afterwards the one giving similar extra focal images was returned.

The old Clark mounting of the 26-inch, which had lain around the observatory for many years, has recently been utilized by Professor Peters of the staff, for the mounting of one of Brashear's photographic doublets for stellar photography. The method of driving of the old Clark has been ingeniously modified by using an electric motor for furnishing the driving power, the governor being used to control the action of this motor. Although it makes a curious looking mounting, I am told that it works very efficiently, and answers admirably for the purpose for which it is used, photographing the minor planets.

Coast and Geodetic Survey.

I had not much time to spare, but looked up Mr. Fischer, head of the instrument division of the survey, whom I had previously met in the inspection of boundary monuments. He very kindly showed me around the building, introducing me to the heads of the various branches, and I had a very pleasant time there. Although the instrument shop is by no means modern, and the machine tools look considerably out of date, they are able to turn out work of the highest class and in considerable quantity. The principal instrument they were then engaged on, was a machine for computing and predicting the tides. They are at present using a small one of a limited number of elements, the purpose of the machine, being of course, the synthesis of the components of the various causes that go to form the tide of any place. The residuals between the computed and actual values though not large, will probably be considerably diminished by taking account of further influences, and the machine is being made to use up to about three times as many elements as the old. Both the principle and the mechanism are rather complex and the workmanship required is of the very highest order, so that the machine will probably require some time to complete.

Mr. Fischer also showed me their instrument room, in which, however, at that time very few instruments were in stock, nearly all being in use in the field. Another interesting room was that containing the circular dividing engine, which is used for graduating the circles of their surveying instruments. Although not a new machine, it gives accurate graduations, and the details of its working were of much interest. I also obtained from Mr. Fischer many interesting items of instrument construction, such as the methods of working and use of invar, aluminum bronze and other special structural materials.

The Flower Observatory.

Philadelphia was reached on Tuesday evening about six o'clock, and after registering at the hotel, an attempt was made to locate the observatory. It was a curious indication of the relative importance of astronomy in the average business man, when I found it impossible, either at the hotel or anywhere in the neighbourhood, to find the location of the Flower observatory, one person indeed directed me to a horticultural pavilion in one of the parks in which was a tower for overlooking the city. The difficulty may be partly accounted for by the observatory being in one of the suburbs. I was finally driven to calling up, by telephone, a leading educational man, I forget his name, and obtaining the desired information from him.

I reached the observatory about nine o'clock and, thanks partly to the kindness of Dr. Brashear, who had written of my coming, I was most kindly received by the family of Professor Chas. L. Doolittle, the director, who was himself observing with his reflex zenith telescope. Dr. Eric Doolittle, who came in shortly after I arrived, showed me the 18-inch equatorial of the Flower observatory, which he uses in measurement of the position angle and distance of double stars. He has already published two volumes of his measures, which are recognized as of high accuracy. He speaks in the highest terms of the quality of the 18-inch Brashear objective, and of the convenience of the Warner & Swasey mounting.

On the next day the director showed me the whole observatory, which, besides the equatorial and reflex zenith telescope, is fitted up for the use of the students of astronomy in the University of Pennsylvania, this observatory being the headquarters of the astronomical department. The work of the director in latitude determinations is well known, and his explanation of the special instrument he uses was of much interest. I spent the balance of the day in his library in the discussion of various astronomical matters of common interest, including the requirements of astronomical libraries.

In this connection, I may mention that at all the observatories I visited, I paid special attention to the libraries and obtained a good idea from them and from the various librarians of the character of the astronomical publications of which we are most in need, and these needed books and publications we are now obtaining as rapidly as possible. Undoubtedly the most complete astronomical library is at the Naval observatory, but the Lick has a good working library, and is considerably ahead of the Solar and Yerkes in that respect. It has, of course, been much longer established and, moreover, the funds at the Yerkes available for additions to the library are extremely limited.

I spent the short time I remained in Philadelphia very pleasantly at the Flower observatory, and I retain very pleasant memories of the kindly nature of my reception and entertainment.

Harvard College Observatory.

I reached Boston early on Thursday morning, and at once went to the Harvard observatory, where I was kindly received by Director Pickering, and shown the nature and examples of the work, especially along the photographic line, done there. As at the Lick and Yerkes, photographic reproductions (generally in the form of transparencies which are frequently enlarged) of the most characteristic negatives obtained in their work, are collected in a large room at the observatory. There are some very fine examples of almost every kind of astronomical photography in this collection, which is a most interesting and instructive one, and I spent considerable time in study and comparison of these examples. The director also showed me their storeroom, containing thousands of star negatives, a complete history of the sky for several years back. It is not once only, but several times, that the usefulness of this collection has been proved as corroborative evidence of later discoveries and this usefulness will by no means diminish as time goes on. He then introduced me to Messrs. Wendell, Gerrish and King, who each, during my stay, were most kind in showing me everything of interest in their particular lines.

Besides the continuous photography of the sky which is being carried on by several equatorially mounted cameras on every clear night, the most important work carried on at Harvard is stellar photometry, and the quantity of this work turned out is wonderful. The director and Professors Bailey and Wendell are those chiefly engaged in it, and many different types of photometers have been and are employed in this work.

The director uses a comparison wedge photometer, the original form of those sent out to different observatories including the Lick and Yerkes and still makes many observations. The photometer is used in connection with an equatorially mounted mirror, which reflects the starlight in a horizontal direction to the photometer eyepiece placed at a convenient height for the observer seated in an ordinary chair. An assistant finds and sets on the stars which according to a well arranged programme are close together in the sky, and records the settings of the wedge while the observer has only to make the settings. In this way measurements are made very quickly and a great deal of work can be done in a night. Professor Pickering told me that he had completed his millionth setting some time back, which is quite a record. The quickness and accuracy with which the settings were made would have been more surprising if one had not reflected that upwards of a million previous observations had given the observer considerable practice and experience.

Professor Wendell, who took great pains in showing me his method of observation does his work with the equatorially mounted refractor, of 15 inches aperture, which is mounted in the main observatory building. Instead of, as the director, comparing the star with a variable artificial star he compares two stars close together in the sky by means of a polarizing photometer. In one form, which is used for stars very close together, a double image prism forms two images of each star, and the comparison is made by the equalizing of the intensity by the rotation of a Nichol prism. The other form of photometer follows exactly the same principle, except that stars at a much greater distance may be compared. A pair of prisms, whose distance may be varied at will, are inserted up the tube of the refractor, and these bring the two images close together in the eyepiece, where they are analyzed as before.

Professor Wendell claims by this method to work to hundredths of a magnitude and its applicability to periodic variables is evident. The variable may always be compared with the same standard stars near it, and results strictly comparable with one another obtained. During the night I visited the observatory, he was measuring the intensity of some planetary satellites. He showed me the light curves of a number of variable stars, the intensities being determined by the method above described.

A third method of determining the magnitudes of stars is a photographic method in which the intensity of the star images on negatives are compared. By this method a great many variable stars in different star clusters have been discovered, and it promises to give very fruitful results. Not the diameters of the images are measured as in the method described by Parkhurst,* but their intensities are compared.

Mr. Willard P. Gerrish, to whom many of the ingenious and original mechanical devices employed on the telescopes are due, showed and explained to me the method of mounting the Common 60-inch reflector. The weight of the moving parts is counterbalanced by the upward thrust of water in which the large hollow polar axis turns. The image is sent by auxiliary mirrors upward along the prolongation of the axis into the eyepiece in the observing room. All movements of the telescope are by electric motors, and the measures of these motions, both in right ascension and declination, are communicated by endless tapes into the observing room where the graduations, which are placed on the tapes themselves, are read through windows in a board side by side, beside which are the switches for the setting motors. The arrangement is most ingenious and convenient, and will permit the required observations to be made with the maximum comfort of the observer, which is essential for the best results.

Mr. Gerrish also explained to me the contrivances by which the equatorial movements to which the various cameras are attached, are driven in synchronism with the sidereal clock. By altering the rate of the clock slightly and changing the adjustment of the axis, the following may be made to correct for refraction over a sufficient range to prevent any drift of the images on the plate. Many other interesting features of the observatory especially relating to the photographic side of the work were shown to me, but my whole visit was too short to obtain the greatest benefit from the many interesting features.

Conclusion.

Perhaps the most pleasant part of my visit to these observatories was the opportunity afforded of making the acquaintance of many of the most noted astronomers of the country. I can only say that I found every one willing in every way to give me help, advice, and the benefit of his experience. It would be, I am sure, impossible to meet in any profession a more companionable or genial class of men, and I carry with me the recollection of many pleasant hours of congenial intercourse. The actual practical benefits from such a trip can hardly be estimated, as one obtains therefrom confidence in himself and his work, knowledge of how best to attack the problems in hand, and the benefit of the experience of others in the smaller details of the work which are never published and which can only be obtained by actual contact and converse with the workers.

THE NEW SPECTROGRAPH.

As outlined in last year's report, the Brashear Universal spectroscope was modified to obtain satisfactory velocity determinations, until a modern spectrograph designed solely for that work could be constructed. My experience with the Brashear instrument had been of service in pointing out what features were desirable and

* Astrophysical Journal, Vol. XXIII, page 79.

what undesirable in a spectroscope for purely radial velocity work, and I set myself the task of designing an instrument which could be used with both high and low dispersions and which, with the limitations of size and weight imposed by the size of the telescope, would be as efficient and accurate as possible.

In this task I did not scruple to avail myself of the most suitable parts of the designs of other spectrographs, and I am indebted especially to the various Brashear spectrographs, and to the Bruce spectrograph of the Yerkes observatory for many of the details of the instrument. Nevertheless, the groundwork of the design and many of the details are new and were developed from a consideration of the requirements, and from a knowledge, founded on experience, of the essential features in the design of a spectrograph for radial velocity work.

The requirements for this instrument may be briefly summarized as follows:—

1. The entire weight with temperature case and all attachments must not much exceed one hundred pounds, which limits the spectrograph proper to about fifty pounds.

2. To prevent as far as possible differential temperature effects, the spectrograph should be constructed of one material.

3. Facility of construction and smaller differential changes of focus with temperature, make brass and bronze preferable for this purpose.

4. The design of the instrument to be such that no direct bending stress shall be applied to any part, but all stresses due to its weight and attachments to a moving telescope, shall act in the direction of extending or compressing members of the framework.

5. The spectrograph to be so devised that it may be used with equal facility with one or three prisms and with linear dispersions of from 60 to 10 tenth-metres per millimetre.

6. The importance of constant temperature in spectrographic work requires an automatic thermostat arrangement for maintaining the temperature constant within 0·1° C.

Many other smaller matters looking towards the convenience and accuracy of its working might be mentioned, but such details will appear in the description.

The Optical Parts.

The angular aperture of the telescope, 1 to 15, determines that of the collimator whose length therefore depends on the aperture of its objective and of the prisms. In choosing the dimensions of the latter, I was guided by the experience of others. Frost found difficulty in obtaining homogeneous prisms with an effective aperture of 51^{mm}. The Mills spectrograph has prisms of 38^{mm}, while the Potsdam, Bonn, Pulkowa and Lowell have prisms of about 30^{mm} aperture. The use of large prisms permits a greater slit width for equal purity of spectrum, and, as my work with the correcting lens has shown, this is a decided advantage as regards exposure time. Considering this advantage on the one hand, and the greater absorption and greater weight of prisms and mechanical parts for large prisms, as well as the possibility of nonhomogeneity of the material on the other hand, the size decided upon was 35^{mm}, which fixed the length of collimator at 525^{mm}.

The glass chosen for prism material was the dense flint (O – 102) of the Jena Glass Works, which has been used on all recent spectrographs. It has high dispersion with remarkable transparency, and is probably the best prism material at present available. The dimensions of the prisms necessary to transmit the full pencil depend upon the angle of incidence, and this will in turn depend upon the deviation of the central ray and the index of refraction. The wave length of the central ray, that at minimum deviation, was chosen at λ4415 as making the best compromise between the shortness of exposure required at λ4500 with the better quality of the spectrum for measurement around $H\gamma$. For mechanical reasons the total deviation of the three prisms was taken as 180°, and this required a prism angle of 63° 45′. For convenience of reference, the formulae required for obtaining the most suitable dimensions of the optical parts will be collected together here.

Let α = angle of prism.
δ = deviation.
a = aperture of collimator.
l = length of side of prism.
t_1 = thickness of refracting edge.
t_2 = thickness of base of prisms at limiting positions of the pencil.
i = angle of incidence.
r = angle of refraction.
μ = index of refraction.
f = focal length of camera.
θ and s = angle and linear distance between any two dispersed rays.

Then at minimum deviation

$$i = \frac{\alpha + \delta}{2} \qquad r = \frac{\alpha}{2} \tag{1}$$

$$\sin\frac{\alpha + \delta}{2} = \mu \sin\frac{\alpha}{2} \tag{2}$$

$$l = a \sec\frac{\alpha + \delta}{2} \tag{3}$$

$$t_2 - t_1 = 2\,a\,\sin\frac{\alpha}{2}\sec i \tag{4}$$

$$\frac{d\,\theta}{d\,\lambda} = \frac{d\,\theta}{d\,\mu}\;\frac{d\,\mu}{d\,\lambda} \tag{5}$$

$$\frac{d\,\theta}{d\,\mu} = 2\sin\frac{\alpha}{2}\sec i = \frac{2\sin\frac{\alpha}{2}}{\sqrt{1-\mu^2\sin^2\frac{\alpha}{2}}} = \frac{2}{\mu\tan i} \tag{6}$$

Using Hartmann's simple interpolation formula for the prismatic spectrum

$$\lambda = \lambda_0 + \frac{c}{\mu - \mu_0} \text{ where} \tag{7}$$

c, λ_0 and μ_0 are constants we get

$$\frac{d\,\mu}{d\,\lambda} = -\frac{c}{(\lambda - \lambda_0)^2} \tag{8}$$

The resolving power R and purity P, are obtained from the following relations:

$$R = (t_2 - t_1)\frac{d\,\mu}{d\,\lambda} = a\frac{d\,\theta}{d\,\lambda} \tag{9}$$

$$\frac{d\,s}{d\,\lambda} = f\frac{d\,\theta}{d\,\lambda} = f\frac{R}{a} = \frac{R}{\beta} \text{ where } \beta = \frac{f}{a} \tag{10}$$

$$P = \frac{\lambda}{d\,\psi + \lambda}\,R \tag{11}$$

where d = slit width and ψ = angular aperture of collimator.

These are all the formulae required for determining the optical constants of a prism spectrograph.

The constants of the particular melting of O – 102, from which the prisms were figured, as furnished by the makers, are as follows:—

Wave Length.	Index of Refraction.
·00006563	1·6413
·00005893	1·6467
·00004862	1·6603

From these values applied in the interpolation formula above given, we obtain the three constants.

$\lambda_0 = \cdot 00002190.$

$\mu_0 = 1 \cdot 61146.$

$c = 6 \cdot 115595.$

and from these constants the following indices of refraction and the $\frac{d\mu}{d\lambda}$ for each wave length were at once obtained by substitution in the above formulae (7) and (8).

Wave Length.	Index of Refraction.	$\frac{d\mu}{d\lambda}$
4862	1·6603	1829
4650	1·6667	2343
4415	1·6701	2636
4342	1·6721	2822
4102	1·6796	3490
4000	1·6833	3983

We have now sufficient data to calculate the required angles of the prisms, the length of their sides, and the resolving power. From formula (2) we obtain $\alpha = 63°$ $44 \cdot 5'$ for a deviation for $\lambda 4415$ of $60°$. The prisms, however, were made of an angle of approximately $63°\ 50'$, and this gives a deviation of $60°\ 10 \cdot 6'$, therefore, from (4) $t_2 - t_1 = 2 \times 3 \cdot 5 \sec 62°\ 3' \sin 31°\ 55'$.

$= 7 \cdot 89$ cms. for one prism.

$= 23 \cdot 66$ cms. for three prisms.

The length of a side of the prism from (3)

$l = 3 \cdot 5 \sec 62°\ 0 \cdot 3'.$

$= 7 \cdot 46$ cms.

Owing to the dispersion and consequent spreading of the pencil, the three prisms were made with sides 75, 80, and 85^{mm} long, respectively, and of 40^{mm} high. While the separate prism for the single prism attachment was made of the same dimensions as the first one above.

In order to obtain any desired linear dispersion within the range of the instrument, three camera objectives of 525, 375, 250^{mm} focus, each of 45^{mm} aperture were ordered from the Brashear Company, but of these only the long focus one has yet been supplied. The problem of obtaining a satisfactory camera lens, one that will stand the critical test for definition and flatness of field required in spectrographic work, is a difficult one and involves greater difficulty for short focus, large angular aperture lenses than for long focus. But I will speak more particularly concerning camera lenses when I come to describe the tests of the instrument. Here it may be of interest to give the resolving power, the purity of the resulting spectrum, and the angular dispersion together with the linear dispersion for each camera when the three prisms are used.

These values were computed by formulae (9), (10) and (11) above.

THREE PRISMS.

Wave length.	Resolving power.	Purity of Spectrum for Slit Widths in Millimetres.				Linear Dispersion Millimetres per Tenth-metre for Camera Focus.			
—	—	·025	·0375	·05	·075	525	375	250	$\frac{d\theta}{d\lambda}$
4862	43260	9770	7130	5534	3843	15·4	21·6	32·3	25·5″
4550	55420	11885	8533	6656	4623	12·2	17·1	25·6	32·7″
4415	62350	13058	9358	7292	5059	10·7	15·0	22·5	36·7″
4340	66750	13790	9874	7690	5456	9·9	13·9	20·8	39·3″
4102	82550	16304	11634	9046	6259	8·1	11·3	17·0	48·6″
4000	94210	18234	12994	10093	6979	7·0	9·8	14·7	55·5″

As each of these values for a single prism is exactly one-third of the above, it is evident that at Hγ we may obtain values of the linear dispersion from about 10 to 60 tenth-metres per mm. It is also evident, taking for granted the relation between slit width and exposure time obtained in the investigation on the 'star image' given below, that there is need for an investigation into the most efficient form of spectrograph—one with low dispersion and long camera, or one with high dispersion and short camera. The same purity of spectrum may be obtained in the latter case with a slit upwards of three times as wide, and hence, even allowing a very large margin for the greater absorption and reflection, the exposure time should be much less. It is proposed, as soon as the two shorter focus cameras are obtained, to make a thorough investigation of the above problem with reference both to early and solar type spectra.

The Frame of the Spectrograph.

Considerable thought was bestowed on the design of the frame of the instrument as, owing to the limitation in weight, it was necessary to choose as self-contained, compact and rigid a form as possible. To my mind, the most important point in the design was to adhere as closely as possible to the simple direct truss form, so that all stresses induced by change of position of the telescope act along the members of the frame. Thus any flexure will only arise by the actual extension or compression of the parts and not by any lateral bending. The design of the Brashear instruments was used as a guide with the difference that, in the triangular, tubular, tripod form of frame, the three tubes were brought much closer together, entering at the prism box into a well braced solid casting and, there almost touching the collimator tube. This is shown in the photographs, figs. 1, 2 and 3, in which the same letters are used throughout to designate different parts. They are indeed so close together that for all practical purposes they may be considered as meeting in a point, and no bending of the casting can alter the position of the line of collimation. This casting A, is continued to act as the base of the prism casting, and the support of the objective end of the camera in the three prism form, and its outer end, which is generally unsupported in other spectrographs, is rendered very rigid in every direction by the diagonal truss B B, which begins at opposite ends of a diameter of the upper ring casting H, continues past the end of the casting A, to which it is rigidly fastened by screws, and again is united almost at a point by a rigid oblong casting C. When the spectrograph is used with a single prism the camera passes close to the end of this truss to which it is firmly united with a rigid tie D. The convergence of these two tubes prevents any lateral motion, and evidently motion in the other direction can only take place by actual extension or compression of the tubes. This diagonal double tubular truss is an essential feature of the design, and serves two purposes—first to stiffen and render practically invariable in position the outer end of prism box and inner end of camera when used with three prisms, and second, to act as a tie to the outer end of the camera when used with a single prism, preventing motion of the camera both tangentially and laterally.

For the same reason that at one end of the tripod shaped truss the tubes are brought as close together as possible, at the other end they are separated as far as possible. The spectrograph truss is made comparatively short in order to be compact and self-contained, and is attached to the solid casting at the eye end of the equatorial by what may be called the telescope truss. This is, as shown, composed of two ring-shaped castings, the lower one E, to which the spectrograph proper is attached, the upper one F, fastened to the telescope, united by three tubes which in the normal position of the spectroscope form prolongations of the three tubes of its frame. The upper ring which is of the full outside diameter of the end casting of the telescope, is attached to the latter by three swivel bolts at the outer edge of the ring and radial with the three tubes. The lower ring has a depression turned in it into which a corresponding elevation on the spectrograph ring fits, thus admitting of turning in any desired position angle. Three clamps G G, also radial with the tubes, admit of rigidly fastening in any desired position. Thus, as stated above, when in normal position, the three tubes are practically continuous from the end of the collimator to the end of the telescope tube, forming an exceedingly rigid truss, while at the same time the spectrograph can be freely rotated and is entirely self contained and compact.

As previously stated, in order to prevent differential expansion with change of temperature, the spectrograph should be made of one material, and brass was chosen for the purpose, both on account of greater facility of construction, and to avoid, as far as possible, change of collimator and camera settings with change of temperature, it being a well known fact that the expansion of a brass tube more nearly compensates the change in focus of the usual type of lenses than iron. To obtain as much stiffness as possible, hard drawn tubing was used for the truss and the castings were of aluminium bronze, which is much stiffer than ordinary bronze or gun metal. The patterns were deeply ribbed, giving the maximum of strength with the minimum of weight.

In the collimator section of the spectrograph, the three inclined tubes are 1¼ inches in diameter, of heavy gauge and are very carefully fitted into their bearings in the ring H and prism base casting A. These of course, form with the diagonal tubes B B, of 1 inch diameter the essential part of the truss, but considerable stiffness is added by the heavy central tube 2 inches in diameter, in which the collimator tube moves, and by the tube I, 1⅝ inches diameter, which carries the comparison apparatus, slit diaphragm, and guiding telescope. After this section had been put together, it was placed between the lathe centres, the axis being the line of collimation, and the upper face of the ring and the lower face of the prism base casting were turned off perpendicular to this axis and perfectly true, ensuring perfect collimation in any position angle, and giving at the lower end a true surface to work from. The telescope truss was similarly constructed and trued, the tubes, however, in this case being of steel, 1¼ inches in diameter, as, since this is independent of the spectrograph, no temperature effect need be feared.

Prism Casting and Cells.

As the photographs, figs. 3 and 4 show, both the prism castings and the cells are made very substantial in order to prevent any relative motion of the prisms with

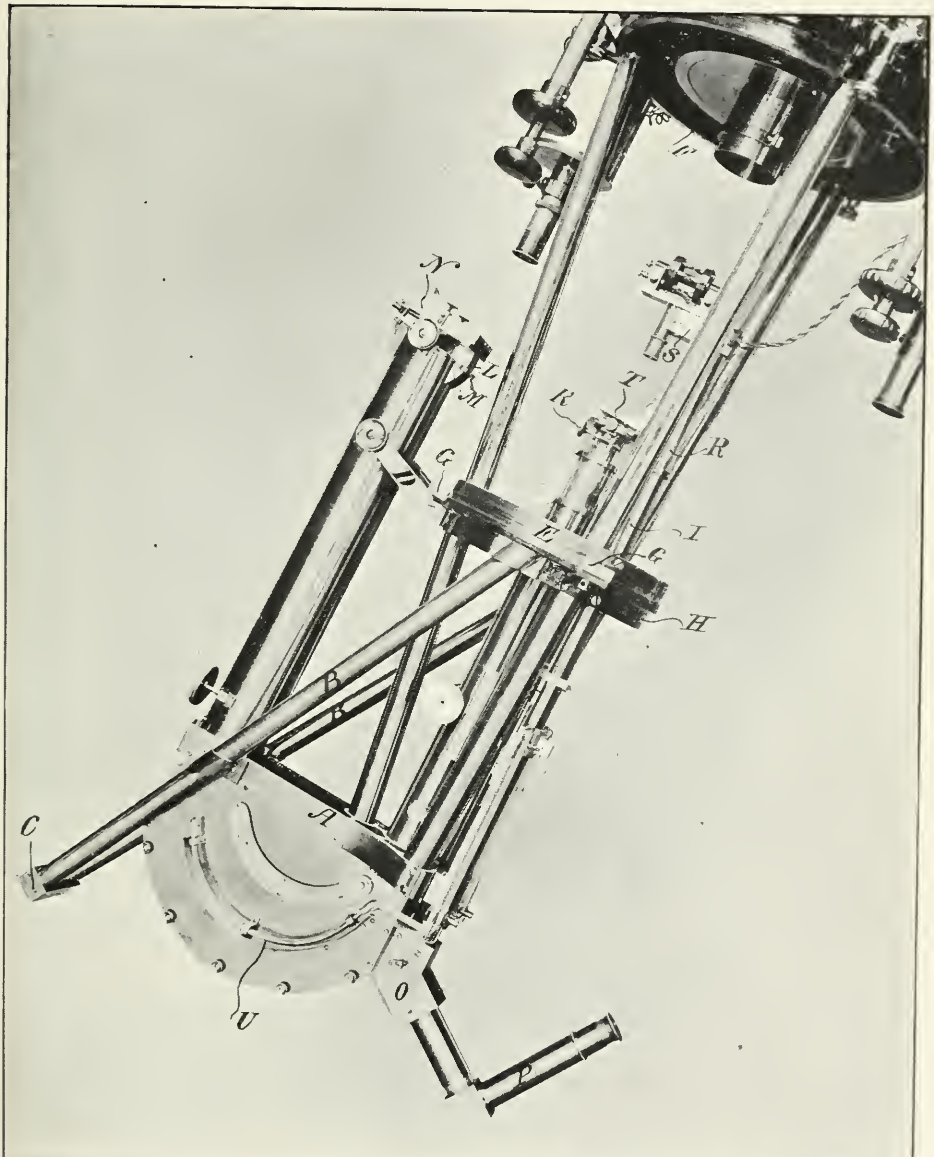

FIG. 1.—Spectrograph—Three prism arrangement.

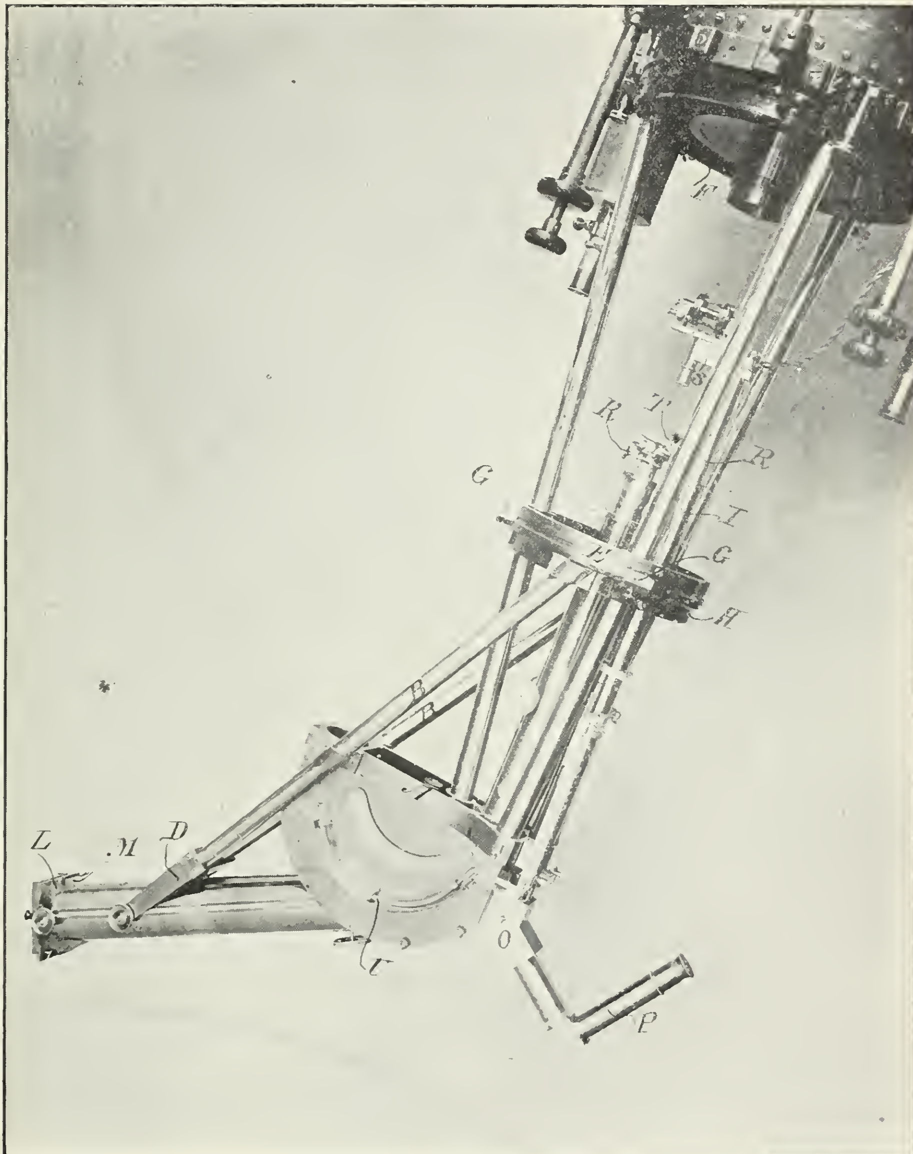

FIG. 2.—Spectrograph—One prism arrangement.

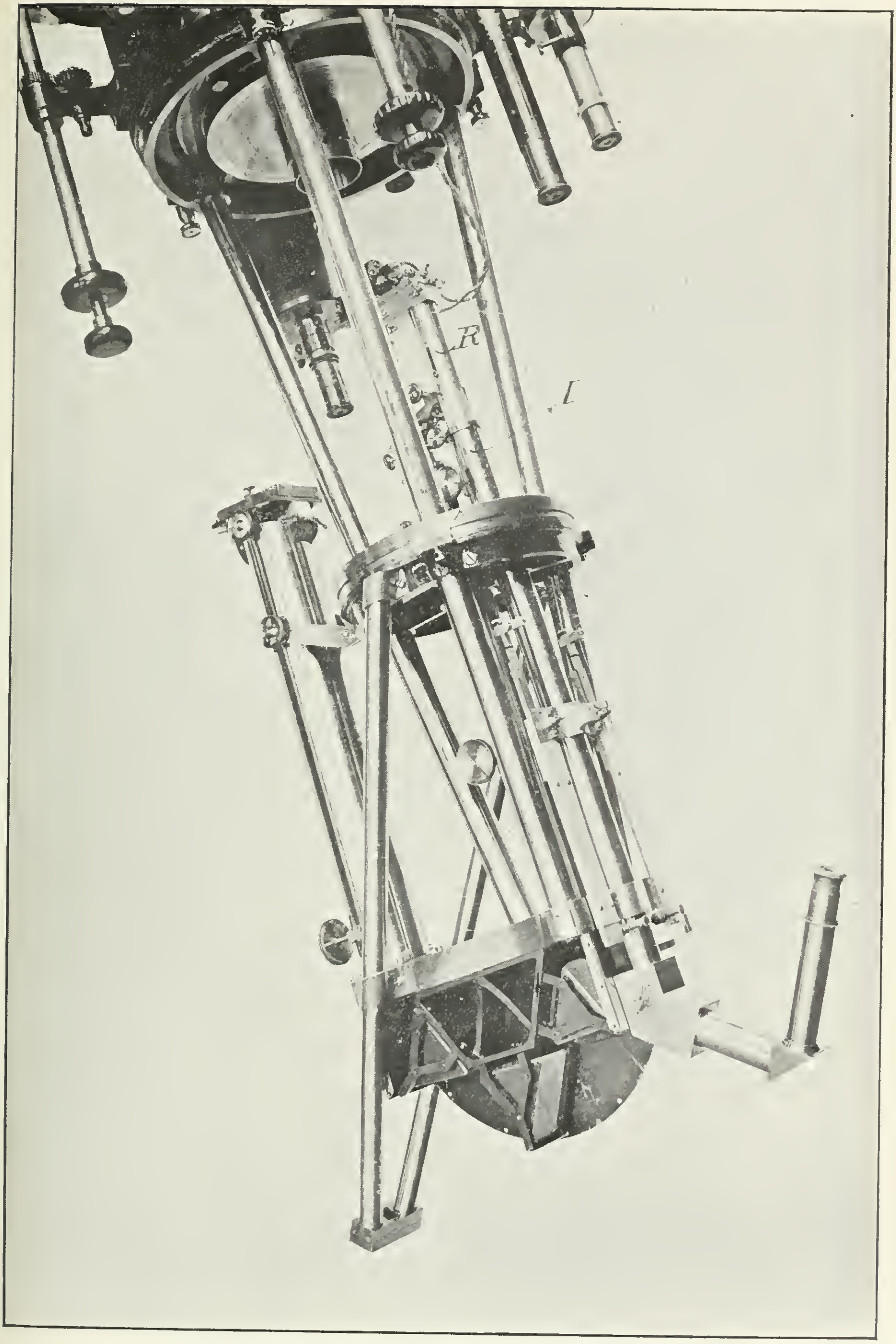

Fig. 3.—Spectrograph with side of prism box removed.

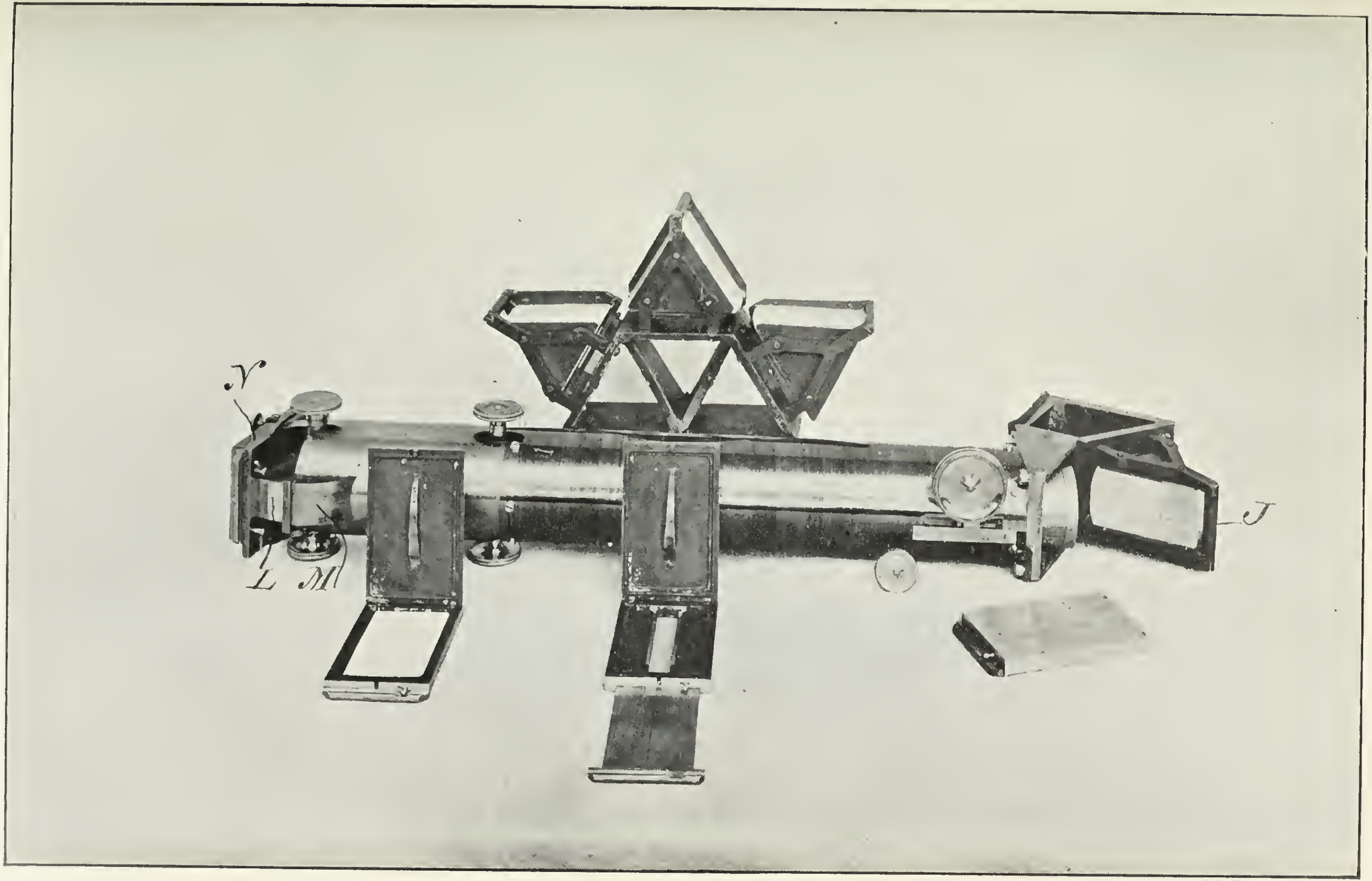

FIG. 4.—Camera, prisms and plate holders.

respect to the rest of the instrument. The braced form of the prism castings for both single and three prisms, together with the amount of metal present, not only effectually prevents any flexure, but also adds considerably to the rigidity of the base casting to which they are firmly screwed. The prism cells are made in one piece, well ribbed for stiffness, and the outer edges, near the refracting edges of the prisms, are connected by a carefully fitted rod J of brass. The prisms are fastened in the cells by gentle pressure produced by three screws pressing on a plate on top of the prism, a piece of blotting paper being placed between glass and metal on both sides. To ensure the maintenance of the prisms in the correct position, narrow brass strips are screwed to the base of the cell abutting against the prism, and preventing it from shifting. Thus only enough pressure need be exerted by the screws to prevent looseness, and no effect on the definition need be feared.

The Collimator.

The collimator objective, made by Brashear, is of Hasting's triple 'Isokumatic' construction, of 35^{mm} aperture and 525^{mm} focus, and is mounted in a tube of $1\frac{3}{4}$ inches diameter, about 19 inches long, which moves by rack and pinion, the position being read on a scale, over a range of about 80^{mm} in the central 2-inch tube. This movement is to allow adjustment for any change in the star focus due to temperature changes, or changes in the correcting lens. The collimator tube, when adjusted, is firmly clamped within the central tube at both ends to avoid any chance of displacement. It is bushed at the upper end to $1\frac{1}{4}$ inches internal diameter to receive the slit tube, and this bush can also be firmly clamped on the slit tube, when the adjustment of the collimator focus is completed. The slit, which was very satisfactorily made for us by Brashear, has inclined, 3·5°, reflecting, speculum metal slit jaws. In accordance with my specifications, the edges of these jaws were brought to a sharp edge instead of being left, as has frequently occurred, about half a millimetre thick. I feared in such case a possible displacement of the spectral lines, owing to uncertainty in position of the effective slit aperture, and corresponding uncertainty of the camera focus. The slit tube is graduated in millimetres and is provided with a tangent screw K, for adjustment in position angle, to enable the lines to be made exactly perpendicular to the length of the spectrum, which allows greater convenience and accuracy in measurement. The interior of the collimator tube is thoroughly diaphragmed to prevent reflections.

The Camera.

Up to the date of writing, only the long focus 525^{mm} camera objective has been completed and consequently only the one camera has been made. As the objective is not achromatic, but composed of two separated single elements of the same glass, light crown, the plate has to be tilted, 5·5° for the three prisms, 16·5° for the single prism, and the camera requires a somewhat different construction from that usually followed, where the tilt is only two or three degrees. This, as is clearly shown by the photographs, consists of one cylinder L, to which the camera back is attached, capable of rotation in a second M, which is attached to the tube, through an angle of some 30°. The inner cylinder is graduated and can be firmly clamped in any desired position by clamp screws on the axis of rotation, as well as on the sides of the cylinder. Besides this motion of rotation, the camera back N, into which the plate holder slides, can move transversely some 15^{mm} on ways, and can be rigidly clamped in any desired position. This motion has been found very convenient, as it allows any number of spectra up to 10 or 12, to be made side by side on the same plate, for comparison in focussing, or for other purposes. The plate holders slide in ways, and are securely fastened down to the same focal plane every time by a pair of clamp screws so that no chance for displacement occurs.

The camera tube, 3 inches in diameter, is made in two pieces, the plate holder end, about 6 inches long, attaching to the objective end, about 15 inches long, and firmly secured with six steel screws well shown in fig. 4. The purpose of this is to enable the camera end, which is troublesome to make, to be used with objectives of different focal length, each fitted into a tube of the required length, some 6 inches shorter than the focus. A pair of large clamp screws both at top and bottom of the camera section, serve to firmly clamp the tie braces D D to the camera. With the long focus camera, the lower screws are used, but with the shorter focus, the upper ones will be required. The objective end of the camera tube is attached to a flanged casting, which is fastened in turn to the prism base casting when three prisms are used, or to the prism casting when a single prism is used, by four screws, and can consequently be quickly and easily attached and detached. This flanged casting is bored out to receive the 2¼-inch tube about 17^{cm} long, containing the two crown lenses, one at each end. This objective tube is focussed by a rack and pinion, the settings being read on a scale with vernier to tenth millimetres, while a clamp screw allows it to be rigidly fastened at any desired setting.

The Plate Holders.

The design of the plate holders was changed from the usual type, in which the plates are supported at the ends only, as tests had shown that successive plates did not occupy the same position with regard to the camera back. Experience with the Brashear spectroscope had shown the necessity of accurate camera focus, for a position of the plate only $0{\cdot}1^{mm}$ from the focal plane would, under the presumption that the distance between the centres of intensity of star and comparison light on the collimator and camera objectives is only 5^{mm}, cause a displacement of the spectral lines equivalent to a velocity of $1{\cdot}8^{km}$ per second. Such a displacement of the starlight can under the present condition of the correcting lens easily occur, as it is impossible to obtain uniform illumination of the camera objectives, and an almost unnoticeably non-central position of the star image on the slit causes a displacement of the centre of intensity to a greater extent than 5^{mm}.

Even if this were not the case, the importance of accurate focus from the standpoint of definition would be a sufficient incentive to any improvement in the methods of obtaining and maintaining it. With the original design of plate holder, any differences in curvature in the successive plates used would change the position of the sensitive surface and, even if one plate were in accurate focus, the next might be as much as $0{\cdot}1^{mm}$ or even more in front of or behind such position. Hence the new plate holders were designed so that the plates are supported as close as possible to the measurable portion of the spectrum. This is effected, as shown in the photograph, fig. 4, by opening the plate holder in the middle similarly to the English book form, placing the plate face downward, resting on a raised portion at the edge of the opening—13^{mm} wide and 76^{mm} long—in the front half of the holder, which is closed by the usual slide. On closing down the back of the holder, a spring presses the plate firmly on this projection. The raised portion consists of two strips at each side of the opening each about 50^{mm} long, and no curvature in the glass can in this case cause any appreciable deviation of the sensitive surface, as the spectrum is nowhere more than 6^{mm} from the support. Great care was taken that, in each of the four holders, the distance of the strips from the front surface, which, is clamped against the camera back, is exactly the same, and this was ensured by taking a light cut over the surface of the strips on each holder after they were finished, the setting of the milling machine remaining unchanged throughout. The size of plate used is 2″ x 3¼″ and the opening in the front of the holder and in the camera back allows a spectrum three inches long and any width up to half an inch to be photographed.

The Guiding Arrangement.

Guiding in the old spectrograph was effected by the starlight transmitted through the slit and reflected from the first surface of the first prism into the guiding telescope. The image could be maintained central, only by keeping it at maximum intensity, and this is not easy, except with stars of about the 3rd magnitude. With brighter stars the image appears too large, and with fainter it is difficult to see. Hence, in the new spectrograph, it was decided to use the light reflected from the slit jaws for guiding, and I am indebted to Prof. Frost's spectrograph for the idea of combining the two methods and using either at will. I did not, however, after obtaining the opinion of other spectroscopists, consider it necessary to use symmetrically inclined slit jaws, for, though unexceptionable in theory, they offer difficulty in practice and introduce complication in uniting the separate images in the guiding telescope. When it is considered, that even in an ordinary inclined slit, the edges of the two jaws, when closed and when open to any width, are always in the same plane perpendicular to the line of collimation, and that the parts of the jaws away from the edges have no action on the light transmitted through the jaws, it is not likely that any error can be introduced by using the simpler form. In order to be able to guide by transmitted light, the guiding telescope must be in line with the light reflected from the front prism surface, and must hence make an angle twice the angle of incidence, or 124° 06′, with the optical axis of the collimator. In order to get the reflected light from the inclined jaws in the same direction, a system of right angled prisms and mirrors must be used. The foundation of the guiding system is a brass tube T, 1⅝″ diameter, parallel to the collimator tube, with a distance of 2⅜″ between centres, and of approximately the same length. At the lower end, this tube carries a box O into which, at the proper angle, the bent guiding telescope P is attached, and which contains a mirror moveable on a pivot at one end into the proper position to reflect light coming down the tube, and which can be turned out of the way of light coming from the prism surface when desired. Into the upper end of this tube slides a second tube R, moved by rack and pinion, and firmly fastened in any desired position by a clamp screw. This carries at its upper end an oblong box S, about 6 inches above the slit, projecting over it, but not far enough to intercept any of the starlight. Within this box at the outer end is a right angled prism, which receives the starlight reflected from the inclined jaws and sends it horizontally to a second prism placed over the centre of the tube, which, in turn, reflects it downward through the tube to an achromatic objective of 1 inch aperture and 10 inches focus. This lens is placed at its focal distance along the optical path from the slit, and sends a parallel pencil down the tube to the mirror, and thence into the guiding telescope. By simply turning the mirror, guiding can be done by the light transmitted through the slit opening or by the part of the light reflected from the polished surfaces of the jaws. It may be stated that guiding is almost entirely performed by the second method, although the first is useful for determining the zero slit opening and for examination for dust, &c. The bent guiding telescope can be rotated to any angle, and thus allows a comfortable position for guiding in any position of the telescope. There is very little loss of light in the optical parts, and one sees the whole slit and diaphragm mechanism as well as if observed direct.

The Comparison Apparatus.

The principal requirements for a serviceable comparison arrangement are convenience in use and permanence of adjustment. Owing to the change in star focus with change of temperature and to the corresponding change in slit position, the upper part of the guiding attachment, the comparison apparatus, and the diaphragms in front of the slit for limiting the star and spark light must be moveable vertically, and this is effected very conveniently in the present instance by attaching them to the moveable tube R, in the upper part of the guiding tube I. A stop on the lower part of the diaphragm is brought almost into contact with the slit head and all three attachments are then in the correct position.

The arrangement of the comparison apparatus is well shown in the different figures and, by swinging between centres in the end of the box containing the guiding prisms, can be turned down always into the same position ready for use, or up out of the way of the starlight, being held there by a spring catch. There are four sets of spark terminals mounted in a drum-shaped arrangement, Fe, Fe – V, Ti, and Cr, and any one of these is brought into position and adjustment by rotating the drum, the position being determined and the contact made at the same time by clamping a pair of screws. A small condensing lens, mounted in a tube below the terminals and in the axis of collimation, serves to form an image of the spark on the slit, a uniform illumination of the collimator lens being further ensured by a piece of ground glass in the upper end of the tube about a centimetre below the spark gap.

In the old spectrograph, the iron spark was used for a comparison spectrum, and, as is well known, gives, when no self induction is included in the circuit, many air lines and considerable continuous spectrum as well as the purely metallic spectrum. The continuous spectrum considerably diminishes the sharpness and contrast of the lines, and settings cannot be so accurately made. When the new spectrograph was brought into use, a plate condenser containing 36 plates about 10 inches by 12 inches in size, arranged so that either 12, 24, or 36 plates could be used as desired, was constructed and placed in parallel across the spark gap to intensify the spark, replacing the Leyden jars which were continually breaking down. A coil of self induction, consisting of 100 turns in three layers of heavy rubber insulated No. 12 wire, wound on a hollow cylinder, into which iron can be placed if required, was also constructed and placed in series with the spark gap. The air lines and continuous spectrum, even with iron which causes more trouble than titanium or iron-vanadium, were then entirely eliminated. A test of the most suitable spectrum led to the choice of iron-vanadium as the lines, although not so plentiful between $\lambda 4600$ and H_β, are much more suitable between $\lambda 4400$ and the extreme violet than in the titanium spectrum. In our single prism work, lines are needed all the way from H_β to K, or even lower.

The Slit Diaphragms.

From experience with the old spectrograph the necessity of absolute independence of slit head and diaphragm arrangement was impressed upon me, and in consequence the attachment T, containing the diaphragms, was fastened to the sliding tube R, above mentioned, and does not touch the slit head or collimator tube at any point. Moreover, as star and comparison spectra are always made of practically the same width, the trouble entailed by an adjustable diaphragm, which is always getting out of adjustment and in which the edges of the tongues are not at right angles to the slit and are thereby objectionable, was obviated by using a fixed diaphragm with an opening on one side $0{\cdot}25^{mm}$ wide for the star spectrum, and two openings $1{\cdot}0^{mm}$ wide separated by $0{\cdot}35^{mm}$ for the comparison spectrum on the other side. This slides, in ways parallel to the slit, into a small carriage which is moved transversely to the slit between stops by a pair of knurled wheels whose rotation through about 40° brings in one direction the star window, and in the second direction the comparison windows directly over and within a half millimetre of the slit. These separate windows are adjustable laterally so that the star spectrum can be made exactly central with regard to the comparison spectrum, and this adjustment when once effected is permanent. If different widths of spectra are required, or different widths of windows for the same width of spectrum, as will be the case when camera objectives of different focal length are employed, separate slides, which are easily constructed, are made for each. In this way the diaphragm can be changed in two or three seconds and always be in correct adjustment and position. All that is necessary in changing from star to comparison spectrum is to turn one of the knurled wheels above mentioned as far as it will go (about 40°) and push down the comparison arrangement, the whole not occupying more than a couple of seconds, while a reversal of this process changes back from comparison to star spectrum. During the whole exposure of star and comparison neither slit nor collimator tube is touched, nor can any pressure be exerted on them by the above changes, and furthermore, the star spectrum is always centrally situated between two equally exposed symmetrical comparison spectra, thus increasing the accuracy and convenience of measurement.

Method of Focussing.

The method of focussing the camera was fully described in the last report, and need not be referred to here, except to state that it is determined by observing the relative displacement of the lines of adjacent spectra, one made through the half of the camera lens and prisms near the refracting edge, and the other through the half near the base. The slit diaphragm used for this purpose has slits of such width that three spectra each, 1^{mm} wide are made side by side and in contact, the centre one through the refracting-edge-half and the two outside ones through the base-half of the prisms. Thus the displacement or non-displacement when in focus of the lines, can be at once accurately determined by mere inspection. A small opening is made in one side of the prism box, directly underneath the collimator, into which a half circle diaphragm slips and which can be turned to occult either half of the collimator lens. Thus by inserting this diaphragm and the proper slit diaphragm, and making two or three exposures on the same plate, the camera being moved transversely in the ways, as previously described, the focus can be accurately determined to $0{\cdot}05^{mm}$ in less than 5 minutes. This is done on practically every evening the instrument is used and ensures, with the new form of plate holder, almost absolute accuracy of focus, at least within considerably less than $0{\cdot}1^{mm}$.

Automatic Temperature Control.

In accurate spectrographic work, the importance of constant temperature of the prisms and of the metal parts of the frame work can not be overestimated, as poor regulation is very likely to introduce systematic displacements of the spectral lines, which in extreme cases may amount to several kilometres per second. If, for instance, just before the comparison spectrum is exposed, the heating current be turned on for two or three minutes, so that the temperature within the case rises one or two degrees, this being quite possible with hand regulation, the expansion of the metal parts may displace the position of the comparison lines, and, if the heat is then turned off, without similarly affecting the position of the star lines. Some experiments made with the single prism attachment of the new spectrograph where, owing to the extended nature of the frame the effect would naturally be large, showed a displacement of the lines in adjacent spectra,—one made when the temperature had been stationary for some time, and the other when the heat had been on for five minutes with a rise of temperature of $1{\cdot}5°$ C. in the outer case,—of $0{\cdot}005^{mm}$ equivalent with the low dispersion employed to about 10^{kms} per second. Moreover, some of the spectra obtained with the Brashear spectroscope show much broadened comparison lines, more so than can be accounted for by flexure, probably due to poor temperature regulation. Some of the measures also show variations from the expected result of greater amount than can be normally accounted for.

Considerable thought was therefore expended on the question of temperature control, and the method used by Hartmann for the Potsdam spectrograph with modifications in the arrangement of the heating coils, was finally adopted as giving the simplest and most practicable solution of the problem. In this method the temperature is automatically controlled by a pair of electric contact thermometers disposed with their long curved bulbs, one on each side of the prism box. One of these with its accompanying guard to prevent accidents is shown at U. The capillaries, of about half a millimetre bore, rise one on each side of the guiding tube to which the scales and supports are firmly attached. The capillaries are open at the end to admit the platinum wires whose positions are adjusted to any desired scale reading by rack and pinion. A platinum wire sealed into the lower end of each capillary forms the second contact and each of these are connected in series with a 300 ohm relay and a couple of dry cells, a spark coil of about 1,500 ohms connected across the gap preventing any oxidation at the mercury surface due to excessive sparking. The scale readings are large, 1° C. occupying a space of about $2{\cdot}5^{mm}$ and thus a difference of temperature around the bulbs, which, owing to their large surface quickly respond, of considerably less than 0·1° C causes contact to be made or broken and the relays to act, breaking or making the heating coil circuits.

The outside temperature case, seen in fig. 5, which is constructed of sheet aluminum lined throughout and all the joints broken with felt to prevent rapid conduction and loss of heat, completely encloses the whole spectrograph and is firmly attached by screws to the three clamps by which the spectrograph is fastened to the telescope truss. Thus the spectrograph can be rotated in position angle and attached to or detached from the telescope without removing the case. The removal of a few screws, however, allows the case to be detached from the spectrograph. Windows to read the prism box thermometer and the electric contact thermometers with doors to admit to the focussing screws, &c., are provided in the sides of the case wherever necessary. It is also arranged with a removeable extension for use with the single prism.

The heating coils are composed of No. 28 German silver wire wound on thin wooden frames and, to prevent accidental contacts and short circuiting, the wire is single silk covered. At first the coils were limited to a single large coil on each side of the case opposite the prism box, as in Hartmann's arrangement, but it was found that, as the temperature outside fell, the temperature in the prism box thermometer dropped about 0·1° C. per hour, even though the heating arrangement appeared to be working perfectly, and although resistance was cut out of the circuit to meet the increased demand. It appeared that this fall in temperature could only be due to the fact that the heating coils were directly opposite and close to the thermometer bulbs and that, although the temperature remained constant at the bulbs and around them, in the other parts of the case it diminished, causing by conduction, &c., the drop observed on the thermometer with its bulb inside the prism box. The application of the guards of bright sheet metal between coils and bulbs advocated by Hartmann, did not do much to remove the difficulty, and moreover, the sensitiveness of the control was much diminished, the time of response of the thermometers being lengthened from about half a minute with moderate heating current, to two or three minutes, thus introducing, to my mind, greater danger of systematic error than the gradual drop before referred to. Additional coils were then inserted to practically cover the two sides of the case and this seemed to remove the greater part of the trouble, for, although there is a slight fall in the prism box thermometer when the room temperature diminishes, if the heating current is turned on when the room is at maximum temperature, this soon ceases and the temperature then remains constant. Although the heating coils are disposed as symmetrically and uniformly as possible, there is no doubt that stratification and non-uniform temperature occur in different parts of the case, and, when the telescope is changed from one star to another, this may give rise to some changes in temperature in different parts of the case. This change of position of the spectrograph is avoided as much as possible by rotation of 180° in position angle whenever the telescope is moved from one side of the pier to the other, the spectrograph being always used with the camera above the collimator. But the only certain remedy for stratification and local inequalities of temperature is some means of stirring the air inside the case. This will entail some difficulty in arranging, owing to the limited space available and to the necessity for keeping the weight at a minimum, but it is hoped before long to instal some such device, the most promising appearing

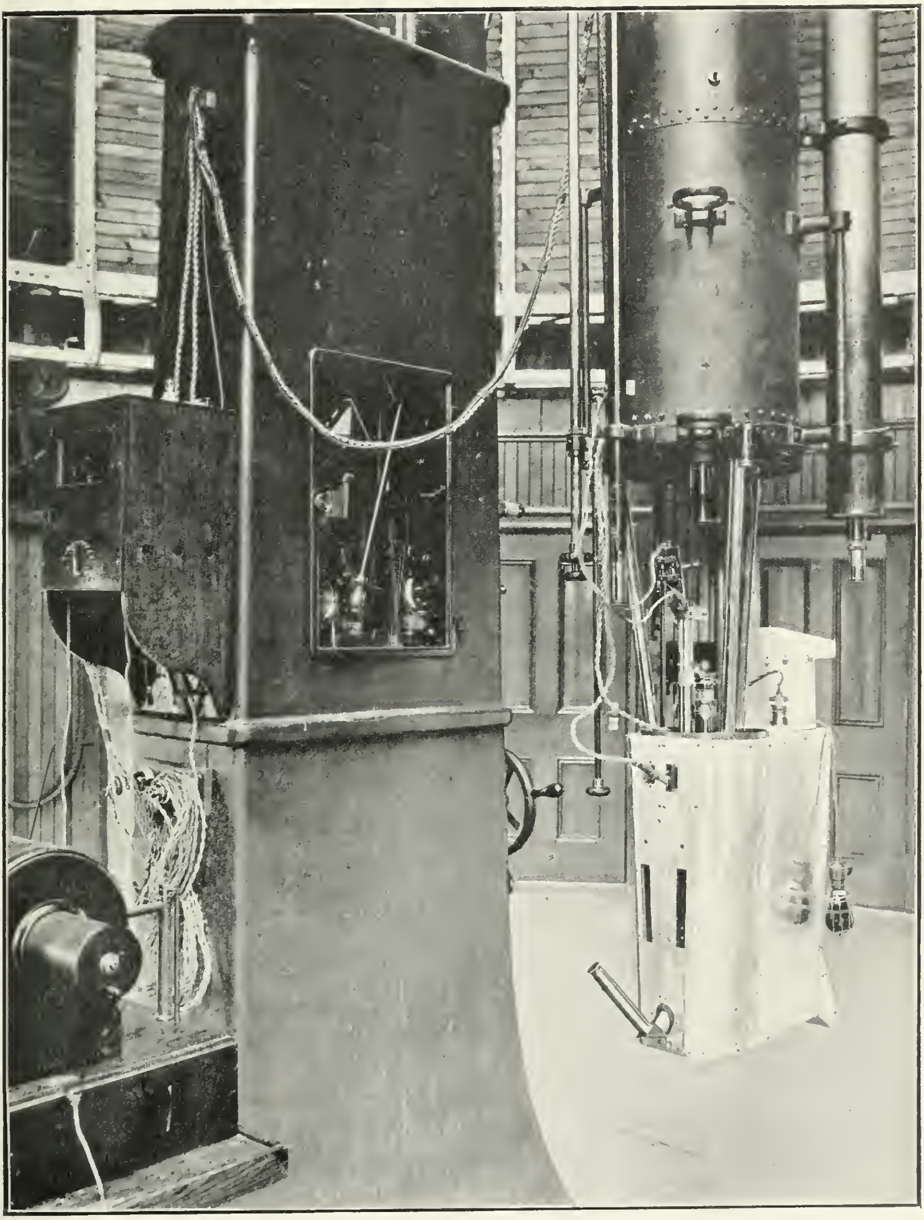

FIG. 5.—Spectrograph ready for work.

to be to place the heating coils in an external case and by means of a fan to force the air through the spectrograph case over these coils, the current in which is turned on and off automatically.

The arrangement of the heating curcuits is very convenient and all connections can be made and the heat turned on in a few seconds. A neat box seen in fig. 5, containing the two relays, connected with the two thermometers, each of which controls the coils on its own side of the spectrograph only, two dry cells for actuating the relays, and a variable resistance for altering the amount of heating current is placed on the south side of the telescope column about six feet from the floor, entirely out of the way of all moving parts. The eight wires, two to each thermometer and two to each side of the heating case, lead from binding posts, properly connected to the relay, battery and resistance terminals inside the box, up the south end of the column and then loop across to the inner side of the tube below the declination axis and down to the eye end. Here they are connected to plugs in three hard rubber blocks which, when shoved into corresponding jacks in the top of the spectrograph and the two halves of the case, complete all the necessary connections, while the relay and heating currents are turned on by a pair of knife switches below the relay box. The wires from the terminals of the induction coil follow the same course up the column and down the tube and there are hence no wires whatever running across the floor to be tripped over or short circuited. The loop in the wires, which are here bound together by tape, from the top of the column to the tube is just sufficiently long to allow free movement of the telescope into every position and can never get in the way or become entangled in any of the moving parts. If it should occur that the spectrograph can not be attached to the telescope when the temperature control is required, a second set of eight wires, leading from the same terminals on the top of the box, end in a similar set of plugs and contact can be completed with the spectrograph in any part of the room in exactly the same way as before. When these wires are not in use they are coiled up out of the way. Two further conveniences are the ten step adjustable rheostat on the relay box allowing the heating current to be varied to suit the difference between internal and external temperatures, and the miniature electric lamps on the top of the relay box in series, one with each of the heating circuits, and showing, by its glowing, when the heat is applied.

It is the custom here, on the nights when the spectrograph is to be used, to place the control in action about 4 p.m., when the temperature in the dome is about its maximum and, if the thermometers are set at this temperature, one may be reasonably certain that the prisms will be in a steady state when observing is commenced, and moreover the initial fall in temperature above mentioned, will have occurred and a constant temperature will be maintained for the balance of the night. Indeed the whole temperature regulation works so well that it requires no attention whatever, while any defect or interruption of its action would be indicated in any case by the cessation of the intermittent lighting or extinguishing of the small lamps, which occurs every few seconds. Owing to these very short intervals and to the small range of response less than 0·1°, the temperature within any particular part of the case must remain very nearly constant. Moreover, the tubular portions of the truss, including the camera, are covered by a layer of felt to completely smooth out any remaining irregularities and ensure no differential expansions during the period of exposure.

General Mechanical Construction.

Before describing the adjustment and tests of the optical parts of the spectrograph, a few words may be appropriately said in regard to its construction. With the exception of the slit head, for which the reflecting jaws could not be made here, the whole instrument was constructed by the mechanician of the observatory, Mr. Alex. Mackey, and I cannot speak too highly of the quality of the workmanship. It is constructed throughout in the best manner, and reflects the greatest credit on his skill.

Considering the amount of work on such an instrument, it was finished in a remarkably short time, and we may consider ourselves fortunate in having so able a mechanician. Our thanks are due to the Brashear Company for the high quality of the optical parts, and for their endeavours to supply us with a wide field camera objective. They have been successful with an objective for use with the single prism which gives the whole visible spectrum in good focus, but have not so far succeeded in making an equally good one for use with three prisms. They hope, however, to solve the problem and to construct an objective that will meet all requirements as to field. If such can be obtained, it will much increase the amount of observational material without increasing the time of exposure as, with a camera lens giving 8° of field instead of 2·5° the usual limit, three times the length of spectrum is measurable and this is a decided advantage in the case of stars with few lines.

Adjustment of Prisms.

Although presumably the bases of the prisms are perpendicular to their refracting edges, I did not know that any special care had been taken to make them so and felt that it would be safer to adjust them so that all their surfaces would be perpendicular to the plane passing through the optical axis of collimator and camera. As the base of the casting A had been turned perpendicular to the plane in question, and, as the bases of the prism castings were milled exactly perpendicular to their sides, the procedure adopted was to lay the castings on their sides on a thoroughly levelled surface plate after the prism cells had been screwed in place, and made as true as possible, and then to place each prism in position on its cell and observe the reflected image through the telescope of a transit, placed in the same horizontal plane. If the reflection of the object glass of the telescope in the polished surface of the prism appeared central with respect to the cross wires, it was presumed that the surface was in adjustment, but if not the cell was shifted on the casting, the bearing parts being filed or scraped where necessary, in order to bring both refracting surfaces truly vertical. After this had been done for all four prisms, the fixity of position was ensured by pinning the cells to the base castings so that in case of removal, they would always go back to the same position.

Focus of Collimator.

The focus of the collimator was determined both by Schuster's method and by Hartmann's extra-focal method. Schuster's method, which is well known and was described in last year's report, gave a value of scale setting of 10·8 as the focal position of the slit, with a probable error of between 0·1 and 0·2. The collimator was taken out of the spectrograph and a small photographic plate was held securely with its sensitive surface against the widely opened slit, a piece of tissue paper being interposed to prevent scratching. The collimator was held in the brackets of the small finder on the equatorial and a diaphragm with a couple of small holes, near opposite ends of a diameter, was placed over its objective. Several extra-focal exposures were made on a star and the measures of the resulting negatives gave a focal setting of 10·6. This is in very close agreement with the value by Schuster's method, as, owing to the thickness of the tissue paper and the wide separation of the slit jaws, the plate would probably be at least $0 \cdot 1^{mm}$ from the plane of the edges and the extra tenth millimetre would readily be accounted for by the lower temperature under which the Hartmann method was used. The collimator setting was therefore fixed at 10·8. After the prisms had been adjusted for minimum deviation at λ4415, which was done in the usual way by an observing telescope, the slit was so adjusted in position angle by the tangent screw K that the lines were exactly perpendicular to the length of the spectrum. This adjustment was obtained by trial photographs, and when finally correct the slit was firmly clamped in place. It may be mentioned here that the deviation of λ4415 was found to be for the three prisms about 180·5° instead of 180°, but the difficulty was overcome by slightly inclining the camera towards the collimator so as to bring $\lambda 4415$ central. This is due to the prisms being ordered in round numbers with a refracting angle of 63° 50′ each, instead of the slightly smaller computed value and possibly to some of them being of a greater angle even than that.

Tests of Camera Objectives.

As previously mentioned, three objectives each of 45^{mm} aperture and of 525, 375 and 250^{mm} focus respectively, were ordered from the Brashear Company, with the proviso that the extent of flat field, within $0 \cdot 1^{mm}$, should be as great as possible, about 8° if obtainable. The field previously obtained from the best triplet objectives does not exceed about 2° 30′. A more recent objective made by Zeiss for Hartmann according to the latter's plan, of the same material as the prisms, the spectrum being obtained in focus by inclining the plate, gives a flat field of 14°. This is considerably greater than needed, as with three prisms about 8° is all that can be obtained without losing so much light at the edges of the field, due to vignetting of the beam, as to be quite useless for star spectrograms. One of these objectives was later ordered from the Zeiss Company, and has recently been received and the result of its test is given below. I therefore suggested to Dr. Brashear that they try to make us some objectives after this plan, and he transmitted the problem to Hastings. The latter did not believe there was anything of value in the idea of using the prism material for the objective, but preferred the plan of using crown glass of the lowest dispersion, separating the two elements and obtaining flatness by introducing oblique astigmatism, which will evidently not affect the sharpness of the spectral lines.

An objective made after this plan was received from the Brashear Company, and as soon as the prisms and collimator were mounted, was tested for field, both with the prism train and with a single prism.

The form of the field was obtained by a modification of Hartmann's method of testing objectives* which is also practically the same method as used here in obtaining accurately the camera focus. Hartmann's method uses small apertures and extra focal measurements and gives better results when used at some distance from the focal plane, while in the method used here the two images of spectral lines are obtained side by side, one through the front and one through the rear half of the camera objective, by means of a suitable diaphragm and the best measurements are obtained when close to the focus as then the lines are well defined. The displacements, though small, correspond to a distance of only two or three-tenths of a millimetre from the focal plane, and consequently accidental errors of measurement of the displacement only introduce small errors, in general considerably less than $0 \cdot 1^{mm}$, in the position of the focus. A great advantage of this latter method is that the form of the field can be determined quite accurately without any measurement or computation whatever, by simple inspection of the displacements with a hand magnifier. As is well known, either of these methods will only give accurate results when the optical system of the spectrograph is free from aberration, and results so obtained should be checked by other methods. This was done in these tests by making a series of spectra at foci differing from one another by $0 \cdot 1^{mm}$, side by side on the same plate, through the full aperture of the system, and judging the position of best focus by comparison of the definition. As the two methods, so far as could be judged by the definition test, gave identical position of the focal plane, it is evident that the results obtained may be used with confidence.

The diaphragm used is inserted just below the collimator lens and is in the form of a semi-circle, which, revolving around its diameter allows, in one position, a semi-circular pencil to pass through the refracting edge, and in the other through the base of the prism and through corresponding portions of the camera objective. When two spectra are made side by side, one through each position, the displacements of the two

* Ztscht. fur Instrumentenkunde, Jan. 1904.

parts of any line gives by its magnitude and sign the distance and position of the focal point for that line, and hence the focus for any part of the spectrum can be obtained and the form of the field determined.

Four objectives were tested.

1. The Hastings-Brashear, single material 525^{mm} focus;
2. The same with enlarged rear element;
3. The Hartmann-Zeiss Chromat of 525^{mm} focus;
4. The Ross Homocentric 10 inches focus.

In each of these cases double test spectra as above described for positions within one millimetre on each side of the focus were made, the displacements were measured and the focal positions computed by similar triangles according to Hartmanns' method. These positions were plotted on cross section paper and a continuous curve drawn through them gives the form of field. In fig. 6 are shown,

(*A*) Curve for No. 1 with single prism from *D* to λ3800

(*B*) Curve for No. 1 with single prism from λ5000 to λ3800.

(*C*) Curve for No. 1 with three prisms from λ4862 to λ4102.

(*D*) Curve for No. 3 with normal separation of the elements.

(*E*) Same with elements in contact.

(*F*) Same with 1·5^{mm} increased separation of elements.

(*G*) Same with 2·25^{mm} increased separation of elements.

The Hastings-Brashear objective is composed of two positive elements of light crown glass, separated from one another a distance of about one-third the focal length. As there is no correction for colour, the plates have to be inclined towards the violet about 5·4° when used with three prisms and about 16·4° with single prism. This objective, as curves (*A*) and (*B*) show, gives almost ideal results with a single prism, the field being almost absolutely flat over the whole range of spectrum obtainable, and would probably extend considerably farther on each end if necessary. There is a portion about λ 4700 where the focus is about 0·2^{mm} shorter than the rest, this being probably due to differences in the ratios of dispersion of the prism and objective material, but, as this comes in a position where there are practically no available star lines and as the deviation is very small, it is unimportant. The angular field between *D* and λ 3800 is about 6°, but there is no doubt that the flat field extends considerably farther on each side. However, for stellar spectroscopy, owing to the steepness of the colour curve of the objective and correcting lens to the red of H_β, and to the violet of H_ϵ, to the diminished sensitiveness of the plates in these regions, and to the increased absorption of the glass and of the terrestrial and stellar atmosphere beyond H_ϵ, the usable portion of the star spectrum is limited to the portion between H_β and *K* and no field beyond that is required. Hence this objective has been adopted for work with the single prism and gives admirable results. It has a further advantage that owing probably to the combination of inclined field, increased dispersion, with increase of temperature, and to the use of a brass camera tube, the focus is practically invariable under all conditions of temperature so far observed.

When, however, the same objective is used with three prisms the field is by no means so satisfactory. As shown in curve (*C*) it is flat in no place but forms a continuous curve not very different from a circular arc. By compromising somewhat, the field is usable between about λ 4325 and λ 4550 an angle of slightly over 2°. This is of about the same order as that given by the ordinary cemented triplet lenses, but is not as good as I should like to obtain for use in spectra with few lines, or even in second type spectra when the measurement is made by means of Hartmann's Spectro-Comparator. Moreover, when this objective is used with three prisms, part of the pencil, near the margins of the field, is intercepted by the cell of the rear element owing to the considerable separation of the elements and to the displacement in position of the pencil in passing through the prisms. This diaphragming begins at about 1·5° from the axis and increases until at the edge of the field, about 4° from the axis,

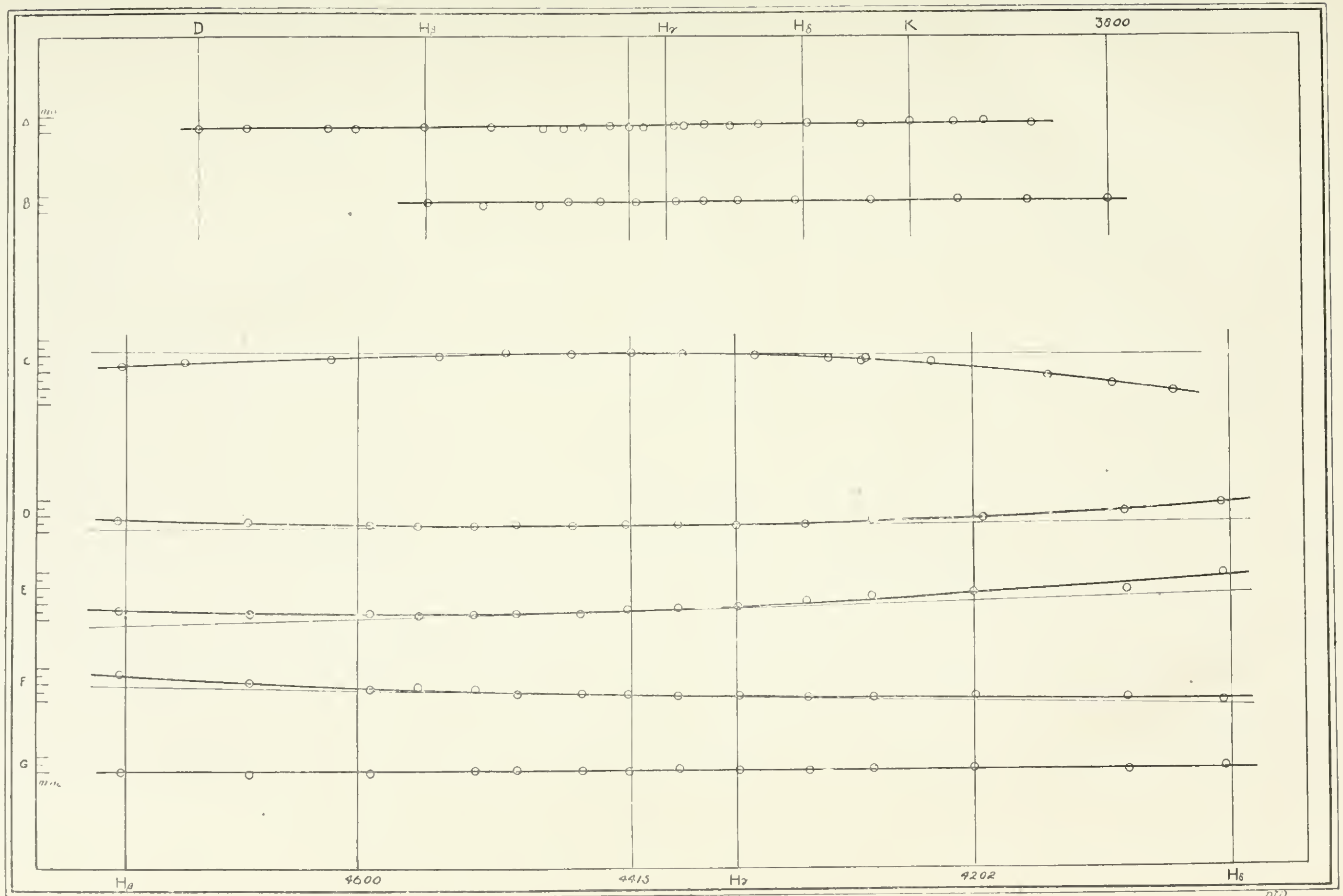

Fig. 6.—Tests of Camera Objectives.

about half the light is cut off. When used with one prism, however, the slight displacement of the pencil and the smaller angular deviation of the usable rays allows it to pass through uninterrupted.

Mr. McDowell very kindly made and figured for me a new rear element with an increased aperture of 15^{mm} which allows the full pencil, even at the margin of the field, to be transmitted. This, which is listed as No. 2, was also tried with three prisms, but, although it gave a more intense spectrum at the edges, the form of field was almost identical, as was to be expected, with the original lens. The plates obtained were not measured or computed, but inspection showed that there was no material difference. The field of the lens with separations of the elements of from 2^{cm} less to 6^{cm} greater than the normal 17^{cm} was also tested, but no improvement was noticed, indeed so far as could be judged by inspection there was very little change either way. Evidently, therefore, this form of objective can not be made to give satisfactory results when used with the dispersion of three prisms, although when used with a single prism the field is all that could be desired.

The favourable report of the performance of the objective made by Zeiss, according to Hartmann's ideas, of the same material as the prisms and described by the latter* led me to have one ordered for our use of 525^{mm} focus and 45^{mm} aperture. This objective has recently reached here and been carefully tested. It gives with three prisms, by slightly changing the normal separation between the elements, a field, fig. 6, *G*, which is practically perfect over the 8° required between H_β and H_δ. With the normal separation the field, fig. 6 *D*, is slightly convex towards the lens, but by putting in a separating ring $4{\cdot}5^{mm}$ wide instead of 2·25, the field becomes flat. The slight original convexity is probably due to slight differences in the average values of the constants of the prism material used in the computation, and the actual values of the melting from which the prisms were made. Indeed the indices of the prism material were some ·002 less than the tabular values. The plate required inclining about 15·3° towards the violet, nearly as much as in the crown lens with single prism. Evidently the inclination of the plate, if the Zeiss lens were used with a single prism, would be about 45°. The lens has not yet been tried with a single prism as the camera does not permit so great an inclination. Besides, it is likely that the field with a single prism would be decidedly convex, and moreover, the field of the crown lens has a moderate inclination and can hardly be improved upon for single prism work.

The problem of flat field camera objectives, so far as regards those of moderately long focus, may then be regarded as satisfactorily solved, but for the shorter focus lenses required 375^{mm} and 250^{mm} focus, with angular apertures of $f/8{\cdot}3$ and $f/5{\cdot}6$ respectively, the same can not yet be said. Such objectives will be principally needed for three prism work, and whether the Hartmann-Zeiss Chromat can be adapted for such large angular apertures is a question I cannot yet answer. If it can, it seems to offer the most hopeful solution of the problem, giving a good field with moderate absorption and only four reflecting surfaces. Failing this, the only hope seems to lie in some of the modern commercial photographic objectives modified to satisfy the requirements in spectrographic work, which are considerably different from those in ordinary photography. In order to obtain a large angular field of moderately good definition, the spherical aberration in most of these lenses is only partially removed and this residual aberration, though unimportant in ordinary photographic work, can not be tolerated in the case of spectral lines which require the sharpest possible definition. Three such lenses in our possession, the Cooke Series III. $f/6{\cdot}5$, the Goerz $f/7{\cdot}7$ and the Zeiss Satz-Anastigmat $f/6{\cdot}3$ were tried with the spectrograph, but the definition, owing to the before-mentioned aberration, was not sufficiently good for spectrographic work. The Ross Homocentric lens is, however, advertised as being free from such aberration, and through the kindness of W. J. Topley & Co., a Homocentric of 10 inches focus $f/5{\cdot}6$ was loaned me for testing. Although no actual tests

* Zeitschrift fur Instrumentenkunde, Sep. 1904.

of the aberration of any of the lenses were made, still the definition tests furnished fair evidence, and the Ross lens gave excellent definition over the 8° of field required. Although no actual measurements of the form of field were made, it evidently is convex towards the lens and of a somewhat similar form and order to the Hastings-Brashear single material objective. Increase and diminution of the distance between the two elements did not apparently improve matters and the lens as it stands only gives from 2° to 3° of usable field. The Ross Company have, however, undertaken the making of an objective, in which, by neglecting the field beyond the 8° or 10° required, they hope to meet my requirements. It is to be hoped that, with Brashear, Zeiss and Ross working at the problem of obtaining a short focus spectrograph camera objective, something of value may result.

The New Spectrograph in Practice.

Since the spectrograph with temperature case was completed about 300 star spectrograms have been obtained, mostly with the single prism and the single material camera, giving a linear dispersion of about 30 tenth-metres to the millimetre at $H\gamma$. Early type binary stars have been the principal ones observed for which this adaptation of the instrument is very suitable for, although the dispersion is only about three-fifths the old spectrograph, the accuracy of velocity determinations is, on account of the greater number of lines measurable, probably in many cases considerably greater while the exposure time required is only little more than half that previously necessary. In stars in which the hydrogen lines are alone visible only $H\gamma$ could be measured in the old spectrograph, while in the new $H\beta$, $H\gamma$, $H\delta$ and if the exposure is sufficient $H\epsilon$ are all measurable, and give generally accordant readings. In cases where the lines are very diffuse, especially if asymmetric, the different intensities of the spectrum at the different lines will evidently be liable to cause discordances. Even in these cases the mean value would be more trustworthy than the value obtained from a single line. The details of some measurements are given below and will give some idea of the confidence that may be placed in the results obtained.

When we come to the spectra of solar type stars in which the number of lines can be equally great in the two cases, the higher dispersion instrument gives, both on account of the less kilometer value corresponding to a given linear value on the spectrum and also on account of the greater purity of spectrum allowing more accurate identifications and wave lengths, much more accurate values. Indeed the probable error of the determination from a single line is only about half as great with the old instrument as with the single prism attachment of the new.

The above discussion refers only to the accidental errors of setting, &c., involved in any measurement of spectra, but takes no account of any systematic displacement which equally affects all the lines. Such systematic error may be due to several causes, the principal of which are three:—

1. Non-uniform illumination of the collimator and camera lenses by either star or spark light or both.

2. Differential displacement of the star lines with respect to the comparison lines due to changes of temperature, this displacement being caused by the change of deviation and dispersion of the prism, or by expansion or contraction of the metal frame work, or by a combination of both.

3. Displacement of the lines caused by flexure of the instrument due to its attachment to a moving telescope.

Symmetry of Pencil.

The distribution of the light in the pencil of rays coming from the slit may be far from uniform in the case of both star and spark light. The latter has usually been the principal one safeguarded, but my experience with the correcting lens has shown that an equal or greater asymmetry is likely to occur with the star light and this, when the image is not free from aberration, is more difficult to guard against. The illumination with the spark light can be readily made and maintained uniform, but if the star image has spherical aberration, which is probably generally present when visual objectives with auxiliary correctors are employed, or if the slit is not in the focal plane of the condensing system then symmetrical illumination of the collimator only occurs when the star image is exactly central on the slit. The fact that the slit jaws are seen by visual light, while the image itself is of blue light in either method of guiding, renders it difficult to get and keep the image exactly central, and consequently, it is probable that the illumination pattern on the collimator objective is rarely symmetrically disposed with respect to a diameter parallel to the slit. Owing, however, to the variations in the seeing and guiding, it is possible that the mean distribution over a long exposure may be sensibly uniform and any displacement avoided, although the definition will be poorer than would be the case under uniform illumination. The possibility still remains that the star light may, during the greater part of the exposure, have its centre of intensity to one side of the centre of the collimator lens, and in this case a systematic displacement of all the lines will occur *unless the camera is in exact focus.* Hence the remedy for this source of error lies in the first place in exact camera focus, in the second in obtaining a star image free from aberration and having it exactly focussed on the slit, and in the third in guiding as accurately as possible. As will have been learned from the preceding description of the spectrograph the first precaution has been most carefully followed. The second defect has already received here much attention,* and good hopes are held forth that the new correcting lens resulting from the investigation of the image given by the old one will give an image reasonably free from aberration. The third precaution is being carefully attended to here, both by the careful design and adjustment of the guiding mechanism and by the care used in following.

The uniformity of the spark pencil is ensured by the careful adjustment of spark gap and large aperture condensing lens in the axis of collimation and further by the insertion of a suitable diffusing screen.

Temperature Effects.

The previous description of the method of automatic temperature control and its efficient working should serve to remove any fear of trouble from this source, but it is proposed to install some means of air stirring in the outside case, and moreover, to try steel tubes for the diagonal brace in hopes of diminishing the displacement caused by any sudden rise in temperature whose amount was given above. The error caused by any possible displacement of this nature is guarded against by dividing the time of exposing the star spectrum into a number of intervals and distributing the comparison exposure equally among these intervals. Thus instead of at beginning and end only, the comparison spectrum is exposed at least four times.

Flexure.

Flexure was one of the difficulties which, in the design of the instrument, special care was taken to overcome as far as possible. Owing to the fact that no material is perfectly rigid there must always be more or less flexure and the only thing that can be done is, with the material at disposal, to render it a minimum. That this was successfully accomplished will be evident from the results of the tests given below. I have no means of comparison with the flexure of other spectrographs except the Bonn, the only one for which the flexure has been published.

The flexure was tested by making two comparison spectra side by side, each in different positions of the telescope, and measuring the shift of the lines.

* Appendix A "The Star Image in Spectrographic Work."

With the telescope at hour angle 0 hrs. the displacement for a movement from declination—20° through 130° to 20° below the pole was:—

For three-prism attachment ·0025^{mm}, equivalent to 1·8^{km}.
For one-prism attachment ·035^{mm}, equivalent to 70^{km}.

With the telescope at declination 0°, and for a movement from 0 hrs. to 4 hrs. in right ascension:—

Flexure with three prisms ·0018^{mm} equivalent to 1·3^{km}.
Flexure with one prism ·007^{mm} equivalent to 13^{km}.
For a movement from 0 hrs. to 2 hrs. in right ascension:—
Flexure with three prisms immeasurable.
Flexure with one prism immeasurable.

The flexure with three prisms even in the test of maximum flexure, swinging in the meridian from the position of camera over collimator to camera under collimator, causes only a very small displacement of the lines, but in the single prism attachment, owing to the extended nature of frame, the linear displacement is some 13 times as great while, owing to smaller dispersion, the kilometer value is forty times as great. A calculation of the displacement of the lines due to the actual extension and compression of the members of the truss, using the best tabular values of the constants obtainable, amounted to nearly as much as the observed value, showing that the design is probably as good as can be obtained. The case of maximum flexure is one that can never occur in practice, where we have to deal with movements of telescope and spectrograph on the polar axis only, and generally not exceeding two hours in duration. For such case, as the tests above show, no measurable flexure occurred even with single prism form when near the meridian, and any systematic displacement from this cause need not be feared. The division of the comparison exposure into a number of equally divided intervals over the star exposure will still further reduce the liability to error even if flexure were present.

In the only published flexure tests I have been able to discover, of the Bonn spectrograph which is of the same form as the Potsdam and Pulkowa instruments, the maximum flexure of this three prism spectrograph is equivalent to 70^{kms} per second and the flexure even for actual exposure conditions of one hour's duration is never less than about 7^{kms}, while no measurable flexure occurs in one hour exposure with either three or single prism Ottawa spectrograph.

The only safe test for absence of systematic error lies in the careful measurement of a large number of plates from one star known not to be a binary, but such test has not yet been made. A few plates of the standard velocity stars have been made, two or three measured, and, so far as this slight evidence can go, no trace of systematic error has been found.

There now follows the measurement of four star spectra made with the new spectrograph which gives an indication of the character of the results obtainable.

α PERSEI.

THREE PRISM SPECTROGRAPH.

Mean of Micrometer Settings.	Measured Wave Length.	Normal W. L.	Displacement.	Velocity.	Mean of Micrometer Settings.	Measured Wave Length.	Normal W. L.	Displacement.	Velocity.
77·6832	4589·660	·126	·466	−30·42	·3086	4400·260	·601	·341	23·24
·4391	4587·955	·381	·426	27·82	·1748	4399·523	·935	·412	28·09
76·8133	4583·668	·018	·350	22·96	46·8821	4397·909	·272	·363	24·75
·3078	4580·040	·407	·367	24·08	·3246	4394·848	·286	·438	31·26
75·7327	4576·052	·512	·460	30·16	44·1940	4383·267	·720	·453	30·99
·1096	4571·743	·156	·413	27·05	42·7832	4375·700	·107	·407	28·38
73·9121	4563·535	·939	·404	26·54	38·3535	4352·475	·908	·423	29·16
·1567	4558·395	·827	·432	30·57	·1666	4351·512	·930	·418	28·81
71·8120	4549·333	·766	·433	28·56	36·7100	4344·060	·451	·391	26·98
69·4682	4533·800	·139	·339	22·41	35·9521	4340·212	·634	·422	29·09
68·6341	4528·334	·798	·454	30·07	·4484	4337·767	·153	·386	26·67
67·7258	4522·426	·855	·419	27·78	33·0144	4325·506	·939	·433	30·00
·3456	4519·967	·397	·430	28·55	32·8591	4324·737	·152	·415	28·76
66·5988	4515·162	·508	·346	22·97	·0162	4320·583	·992	·409	28·38
65·4857	4507·047	·455	·408	27·13	30·8379	4314·813	·178	·365	26·44
64·3891	4500·103	·448	·345	22·99	·6568	4313·930	·321	·391	27·18
63·3002	4494·270	·664	·394	26·28	·3858	4312·663	·051	·388	26·97
62·8115	4491·220	·621	·401	26·76	29·7029	4309·302	·652	·350	24·43
61·1626	4480·009	·438	·429	28·71	·3578	4307·634	·891	·357	24·84
60·3209	4475·844	·214	·370	24·77	27·7308	4299·832	·211	·379	26·42
58·7496	4466·300	·711	·411	27·60	26·6206	4294·558	·936	·378	26·38
57·5198	4458·905	·304	·399	26·82	·4758	4293·873	·273	·400	27·92
56·0778	4450·330	·719	·380	25·61	23·9838	4282·200	·565	·365	25·84
54·9307	4443·577	·976	·399	26·92	22·3278	4274·571	·911	·340	23·85
50·2344	4416·590	·985	·395	26·82	17·7917	4254·117	·505	·388	27·36
48·0797	4404·527	·927	·400	27·24	16·8377	4249·911	·287	·376	26·53
47·4854	4401·235	·581	·346	23·56	13·5713	4235·691	·112	·421	−29·79

Mean		−27·03
V_a	+25·10	
V_d	·10	
Curvature		− ·28
Radial velocity		− 2·1

θ AQUILAE.

ONE PRISM SPECTROGRAPH.

Line.	Wt.	Mean of Settings.	Corrected Setting.	Normal Setting.	Displt. in Revns.	Velocity.
λ4864	2	73·0432	....	....	....	....
Hβ λ4861	1½	72·9345	·9002	·8648	·0354	+51·36
λ4851	2	·4820	....	....	....	....
λ4494	2	54·7632	....	....	....	....
4481	1½	·0495	·0265	·9698	·0567	+64·81
λ4466	2	53·1355	....	....	....	....
λ4341	2	45·2935	....	....	....	....
Hγ λ4340	2	·3185	·2987	·2387	·0600	+62·64
Hδ λ4102	1½	27·5148	·4855	·4219	·0636	+55·20
λ4099	2	·2760	....	....	....	....
K λ3933	1½	11·9599	·9419	·8514	·0905	+68·15
λ3930	2	11·5250	....	....	....	....

Weighted mean		+60·57
Va	−28·10	
Vd	− ·04	
Curvature	− ·28	
Radial velocity		+32·1

o ANDROMEDAE

ONE PRISM SPECTROGRAPH.

Line.	Wt.	Mean of Settings.	Corrected Setting.	Normal Setting.	Displt. in Revns.	Velocity.
λ4864	1½	72·9847				
H_β λ4861	3	·8276	·8000	·8187	·0187	−27·17
λ4851	½	·4292				
H_γ λ4341	1½	45·2720				
λ4340	2	·2022	·2138	·2489	·0351	−36·75
H_δ λ4102	1½	27·4185	·4604	·4965	·0361	−31·48
λ4099	2	·2800				
H_ϵ λ3969	2	15·4476				
λ3970	½	·4760	·5576	·6035	·0459	−35·71

Weighted mean ... . −32·29
V_a .... +20·55
V_d .... + ·15
Curvature .... − ·28

Radial velocity.... .... −12·9

α BOÖTIS.

ONE PRISM SPECTROGRAPH.

1907. May 24.
G. M. T. 15ʰ 22ᵐ

Observed by J. S. PLASKETT.
Measured by J. S. PLASKETT.

Wt.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W. L.	Displacement.	Velocity.	Wt.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W. L.	Displacement.	Velocity.
1½	59·0211	4571·895	·865	·758	+ ·107	+ 7·01	2	43·7916	4318·962	·967	·817	·150	+10·41
2	57·8276	4549·896	·848	·766	·082	+ 5·40	2	40·7733	4275·147	207	·922	·285	+19·98
1½	57·5687	4545·179	·135	·845	+ ·290	+19·14	1½	39·3174	4254·658	·720	·505	·215	+15·16
1	57·0595	4535·955	·923	·964	— ·041	— 2·71	2	37·9807	4236·203	·251	·141	·110	+ 7·79
1	56·8119	4531·496	·468	·355	+ ·113	+ 7·48	1½	37·5352	4230·126	·166	·845	·321	+22·76
1	56·5462	4523·156	·148	·985	+ ·163	+ 7·49	2	35·8247	4207·130	·137	·028	·109	+ 7·76
1	56·2021	4520 588	·583	·363	+ ·225	+14·92	2	35·4619	4202·320	·320	·161	·159	+11·34
2	52·8314	4462·100	·240	·967	+ ·273	+18·35	2	34·6641	4191·824	·827	·654	·227	+16·23
1	50·9497	4430·720	·836	·678	+ ·158	+10·70	2	33·9069	4181·964	·974	·947	·027	+ 1·22
2	50·7644	4427·678	·778	·420	+ ·358	+24·24	2	31·5872	4152·360	·424	·223	·201	+14·58
2	50·0134	4415·432	·500	·354	+ ·146	+ 9·91	2	31·2119	4147·654	·726	·587	·139	+10·06
2	49·3724	4405·080	·114	·951	+ ·163	+11·08	2	30·1597	4134·582	·686	·676	·010	+ ·72
1	48·7820	4395·642	·642	·426	+ ·216	+14·73	1½	29·6231	4127·983	·003	·029	—·026	— 1·89
1½	47·8569	4381·008	·996	961	+ ·035	+ 2·39	3	29·2754	4123·732	·866	·841	+ ·025	+ 1·82
2	47·0392	4368·235	·183	·841	·342	+23·48	2	29·1154	4121·782	·918	·639	+ ·279	+20·31
2	47·2546	4371·585	·537	·343	·194	+13·31	2	28·6926	4116·647	·793	·739	+ ·054	+ 3·94
1	47·1582	4370·080	·030	·867	·163	+11·18	2	26.6798	4092·580	·840	·626	+ ·214	+15·69
	45·2570	4340·912	·882	·634	·248	+17·14							

Weighted mean............ ...... +11·23
V_a .... −15·95
V_d .... − ·02
Curvature .... − ·28

Radial velocity............... − 5·0

MEASUREMENT AND REDUCTION OF SPECTROGRAMS.

The spectrograms taken with the Brashear spectroscope have all been measured and reduced in the way described in last year's report, by reducing all linear measures to wave lengths by the simple form of Hartmann's interpolation formula

$$\lambda = \lambda_0 + \frac{c}{s_0 - s} \text{ where}$$

s = linear value of line

λ = wave length

and c, λ_0, s_0 are constants.

Owing to the known temporary use of this spectroscope, and to the fact of its being of an adjustable type, it was not thought worth while to develop a shorter method of reduction. But when the new spectrograph was completed and tested, and when it was found that the Brashear single material camera objective gave such excellent results in single prism work, a shorter method of reducing the measurements of the single prism plates was evolved. In the method previously used. every linear measurement had to be reduced to wave lengths by the above formula which involves the looking up of a logarithm and an anti-logarithm, a subtraction and two additions, all of seven figures, and besides this the constants of the formula, a matter of fifteen or twenty minutes work, have to be obtained. Hartmann, to whom we owe so many valuable methods and devices in spectrographic work, has, in A. N. No. 3703, described in full detail a method for avoiding most of this tedious and laborious work, which has been, in a somewhat simplified form, adapted for use here. In this method, instead of reducing each measure of each line to its wave length by the interpolation formula, tables are made in which the wave lengths of all star and comparison lines are reduced to their corresponding linear measures or micrometer readings by the same interpolation formula. The displacements in kilometres per revolution of the micrometer screw for every wave length are also computed and tabulated, and the differences between the tabulated micrometer reading for any star line and the actual measured reading, when reduced to the same zero, multiplied by this value gives at once the velocity in kilometres for that line. When a set of tables are once obtained in the manner described below, not only is the determination of the constants of the interpolation formula avoided, but all the laborious logarithmic computation is done away with, and the displacements are determined at once by simple subtraction after the measurement has been brought into coincidence with the standard by a graphical interpolation of exactly the same nature as required in the previous method.

When a spectrograph for radial velocity work has been brought into adjustment, such adjustment, so far as position of the prisms and focus of the collimator is concerned, remains permanent and the spectra produced, so long as the temperature is the same, are identical. If the temperature changes, the deviation and dispersion of the prism changes and there is also, in general, a slight change in the focus of the camera. In consequence the distance between any two lines in the spectrum is a function of the temperature only, increasing slightly with increase of temperature. Hence, in constructing the tables of micrometer revolutions of star and comparison wave-lengths above mentioned, we have to take into account this variation and construct tables for different temperatures. Owing to the smallness of the variation, it has been found sufficient to construct a table for every 10° C change of temperature and hence 6 sets of tables will be sufficient over the whole range actually occurring from −20° to +30° C.

It has been found in practice that, owing probably to accidental errors of setting on the comparison lines used as standards, the three constants of the interpolation formula obtained by choosing three lines with their known wave lengths and micrometer readings, substituting and solving in the formula, vary considerably in different spectra, even when made at the same temperature. It was necessary, therefore, in order to obtain a harmonious set of tables, varying continuously with the temperature, to eliminate these accidental variations and the method pursued was one of averages combined with an assumed simple continuous change of the measurements and values of the constants with varying temperature. This assumption, though perhaps not strictly true, is convenient in use and, as it can not introduce any error in velocity determinations, has been used.

A number of spectra of the Fe-V spark, three or four at each temperature, were made at five different temperatures between 14·6° and 30° C. The greatest care was taken in making these spectra, not only in having the camera accurately focussed, but also in ensuring uniform temperature conditions in the prism, this being obtained by maintaining the whole instrument at constant temperature for several hours before exposure. About 20 good lines between λ 3930 and λ 4875 were measured on a selected plate at each temperature, and of these 20 lines, three were selected as standards for determining the constants of the interpolation formula. The choice was made, after trial of several sets, of the three in which the residuals between the computed and known values of the wave lengths of intermediate lines and of lines at the ends of the spectrum were a minimum. The three lines finally chosen as standards were λ 4594·216 V, λ 4395·382 V, and λ 4202·195 Fe. With these standards an attempt was made to reduce the above mentioned residuals by using the complete Hartmann interpolation formula $s_0 - s = \frac{c}{(\lambda - \lambda_0)^a}$ where a may be given any value, Hartmann has found in the Potsdam spectrograph that a value of 0·6 for a gives the lowest residuals. A trial was made here by Mr. N. B. McLean, who made all the computations required in this work, of three values of a, 0·5, 0·7, and 0·9, as well as unity, but the residuals were lower with the simpler form of a as unity than in the others.

In bringing together, in the table below, the micrometer readings of the three standard lines with the corresponding calculated constants for five temperatures, all the readings have been reduced to the same value for the standard λ 4395·382 of 48·7700. This brings the line at minimum deviation λ4415 very near the reading 50 or the centre of the micrometer screw, which has an effective length of 5^{cm} and is of 0·5^{mm} pitch. Every star plate measured is so set on the stage as to bring λ 4395·382 as near as possible to reading 48·77, but any small deviations are of no moment, as their effect is removed in the curve drawing to be presently described.

TABLE OF CONSTANTS.

Temp. C.	4594·216	4395·382	4202·198	s_0	log c	λ_0
	s_1	s_2	s_3			
14·6°	60·1754	48·7700	35·4949	184·8423	5·4709008	2222·025
17·4	60·1809	48·7700	35·4836	184·6549	5·4694204	2226·434
21·1	60·2038	48·7700	35·4469	184·4126	5·4668483	2235·390
25·4	60·2115	48·7700	35·4520	185·2279	5·4719729	2222·810
30·0	60·2098	48·7700	35·4366	184·3153	5·4659474	2238·319

As will be noticed in the table, there is a general progression of the values for the micrometer readings and constants with the temperature, but this is not uniform and, for one temperature, 25·4° C., the readings and constants are markedly variant. This is probably due to some slight difference in the inclination of the plate in this spectrum, and it was consequently omitted from the discussion. In order to obtain uniformly progressive values, the accidental discrepancies due to accidental errors of setting on the lines, deviation from the true camera focus and plate inclination, or inaccurate temperature determinations must be removed. If we form a table of the differences between the readings $s_1 - s_2$, $s_1 - s_3$, $s_2 - s_3$, and the ratio of the first two we should be

Temp. C.	$s_1 - s_2$	$s_2 - s_3$	$s_1 - s_3$	$\log \frac{s_1 - s_2}{s_1 - s_3}$
14·6°	11·4054	13·2751	24·6805	9·66476
17·4	11·4109	13·2864	24·6973	9·66467
21·1	11·4338	13·3231	24·7568	9·66450
25·4	11·4415	13·3180	24·7596	9·66474
30.0	11·4398	13·3334	24·7731	9·66444

able to form a progressive series. The ratios in the last column are nearly constant, but omitting the discrepant temperature 25·4° and allowing for accidental errors, a small regular decrease with increase of temperature is evident, which amounts to nearly 2 in the fifth place per degree. A comparison of the figures in the fourth column also indicates a change of about 0·007 revolution per degree. If we form an arbitrary series from the last two columns, using values averaged from them for the middle of the range together with the differences above quoted and computing $s_1 - s_2$ and $s_2 - s_3$ from them, we obtain the following values:—

Temp. C.	$s_1 - s_2$	$s_2 - s_3$	$s_1 - s_3$	$\log \frac{s_1 - s_2}{s_1 - s_3}$
0°	11·3630	13·2110	24·5740	9·66502
10°	11·3902	13·2538	24·6440	9·66482
20°	11·4173	13·2967	24·7140	9·66462
30°	11·4444	13·3396	24·7840	9·66442

Which combined with a reading of 48·77 for s_2, give the following continuous values of s_1 s_2 s_3 from which the constants given for 10° 20° and 30° C were obtained.

Temp. C.	4594·216	4395·382	4202·198	s_0	log c	λ_0
	s_1	s_2	s_3			
0°	60·1331	48·7700	35·5591			
10	60·1602	48·7700	35·5162	184·8465	5·4715619	2218·782
20	60·1873	48·7700	35·4733	184·5845	5·4686837	2228·988
30	60·2144	48·7700	35·4304	184·3133	5·4657512	2239·261

With these constants, the micrometer readings corresponding to the normal wave lengths of the comparison and star lines used were computed and tabulated separately, small portions of these tables being given below. It is also necessary, as the velocities are now to be computed from micrometer instead of wave length displacements, to obtain the velocity value of one revolution of the micrometer screw in kilometres per second for every star wave length used, and to tabulate these along with the wave lengths and micrometer readings of the star lines. In the formula,

$$s_0 - s = \frac{c}{\lambda - \lambda_0}, \text{ by differentiation}$$

$$ds = \frac{c\, d\lambda}{(\lambda - \lambda_0)^2}, \text{ and by Doppler's principle}$$

$$v = 299860 \frac{d\lambda}{\lambda}, \text{ and substituting value of } d\lambda$$

$$v = \frac{299860}{\lambda} \quad \frac{(\lambda - \lambda_0)^2}{c}.\ ds$$

FE. V. COMPARISON LINES.

Wave Length.	Micrometer Readings.		
	10°	20°	30°
4875·674	73·3689	73·4161	73·4628
4871·453	73·1914	73·2386	73·2850
....	......	....	....
....	....	....	....
4404·929	49·3612	49·3658	49·3676
4400·738	49·1040	49·1049	49·1058
4395·382	48·77	48·77	48·77
....	....	....	....
....	....	....	....
3969·411	15·6591	15·5292	15·3986
3930·450	11·8081	11·6580	11·5072

STAR LINES.

Wave Length.	10°C		20°C		30°C	
	Micrometer Reading.	Velocities per Revn.	Micrometer Reading.	Velocities per Revn.	Micrometer Reading.	Velocities per Revn.
4861·527	72·7721	1454·4	72·8187	1452·8	72·8648	1451·2
4713·308	66·1128	1336·6	66·1505	1334·5	66·1879	1332·4
....	......	......	......	....	....	....
....	......	......	....	......	....	....
4340·634	45·2589	1050·1	45·2481	1046·9	45·2387	1043·7
4325·939	44·2854	1039·1	44·2723	1035·9	44·2592	1032·7
4320·992	43·9547	1035·4	43·9405	1032·2	43·9264	1029·0
4318·817	43·8087	1033·8	43·7941	1030·6	43·7795	1027·4
....	....	.....	......	......	....	......
....	....	......	....	......	....	.....
3964·875	15·2197	778·5	15·0874	774·5	14·9546	770·5
3934·825	12·2493	757·6	12·1015	753·6	11·9531	749·6

The process of reducing the measurement of a star spectrum now becomes considerably simpler. The measurement is performed as before, the plate being set in the first position, with the red end of the spectrum to the apparent right, so that when the V line 4395·382 is under the cross wire the screw reading is nearly 48·77. On the reversal of the plate this reading should become 51·23. After the mean of the two settings is taken, the table of comparison lines whose temperature argument is nearest to the temperature at which the spectrum was taken, or preferably the one in which the difference in the micrometer values for any two comparison lines agrees most closely with the measured value, is placed beside the mean readings and the differences between the two are plotted on cross section paper as ordinates, with micrometer readings as abscissae. Through the points thus obtained, a smooth curve is drawn which fills an exactly similar purpose to the curve used in the former method for obtaining the corrections to the star lines, and although open to the objection expressed by some observers of arbitrariness, nevertheless seems to me to be preferable to direct interpolation between adjacent comparison lines, as getting rid of some accidental errors. As it is impossible to know beforehand what effect any particular method of curve drawing will have on the resultant value, any fear of prepossession is removed. Corrections to the micrometer readings for the star lines are taken directly from this curve, and the corrected readings, which reduce the star lines to the same zero as the comparison lines, are then put down in a column next to the mean readings. The differences between these and the corresponding tabular values give the displacement due to motion in the line of sight which multiplied by the tabulated 'Velocities per Revolution' give the velocity at once. The work required is the same as in the previous method after the computed wave lengths have been obtained and all the laborious determination of constants and calculation of the wave lengths is avoided. Moreover, the liability to numerical mistakes is much lessened and these advantages are obtained without loss of accuracy in the resulting velocity. Any variation in the velocity obtained can only be due to differences in the drawing of the interpolation curve in the two cases and this can only be slight in any event.

Two or three measurements have been reduced by both methods, an example of which is given below, with resulting values within two-tenths of a kilometre of one another which has no significance in single prism work. Furthermore, as an evidence that the interpolation is linear and that the curve drawing is not likely to introduce error, the same measurement has been reduced by using tables for two different temperatures with exactly the same result.

The correction for curvature is applied by Hartmann to each star line of the spectrum and he has developed a system for all cases that may occur. In the case of the single prism plates the correction for curvature is so small, amounting to from ·00024 to ·00032 revolutions that the error introduced by using either 2 or 3 in the fourth place will amount to more than can occur by forming an average correction in velocity and applying it at the end of the reduction. The correction was obtained by measuring the abscissas and ordinates of the parabola formed by long spectrum lines and obtaining the constants of the equation. These equations which range from $x = \cdot 00096\ y^2$ for λ 4875 to $\cdot 00127\ y^2$ for λ 3968 where x is the correction and $2y$ the distance between the points of measurement on the comparison lines. This reduced to velocities gives for the usual distance between the tips in our measurement from $0\cdot 29$ to $0\cdot 26^{\text{kms}}$ per second, or in the mean 0·28, and is of course, applied with the negative sign.

The various sources of errors in the measurement and reduction of spectrum plates were discussed in last year's report, and it may be said that further experience has not led to any modification of the statements therein. Any method based upon the use of an interpolation formula depends for its accuracy on a knowledge of the true wave lengths of the star lines, and such are not yet at hand. For stars of early type, it is probably the best means available for obtaining the velocity, but for solar stars in which, although the wave lengths of the single lines are known fairly accurately, the wave lengths of complex blends, such as inevitably occur in low dispersion spectra, are very uncertain and the error introduced correspondingly large. An evidence of this is given by the high residuals from the measurements of even such stars as Arcturus, where great care was taken in the choice of the least complex lines. It must be remembered, however, that the linear dispersion with a single prism is only one-third of the three prism instruments and is at $H\gamma$ about 30 tenth-metres to the millimetre, so that an accidental error of setting of $0\cdot 005^{\text{mm}}$ corresponds to over 10^{km} velocity. In consequence of these conditions, the production and measurement of solar type spectra with the single prism instrument is being held over as much as possible until the spectra-comparator is received. In this instrument trouble with blends and identifications is to a great extent avoided, as no accurate knowledge of wave lengths is required, and the displacement is obtained by direct comparison with some standard plate, whose velocity value is known.

The corrections for diurnal and annual motion are applied in the way described last year, and no further description is here required.

RADIAL VELOCITY.

Star, η Boötis 812.
Date, June 10, 14h 10m
Hour angle, 30m W.

Observer, J. S. Plaskett.
Measurer, W. E. Harper.
Computer, W. E. Harper.

Weight.	Micrometer Readings.		Means.	s_o 184·0358 $(s_o - s)$.	$log\ (s_o - s)$.	$log\ c.$ 5·4659650 $log\ (\lambda - \lambda_o)$	$(\lambda - \lambda_o)$.	λ_o 2234·279 λ	Normal W. L. Comp. Lines.	Corrected Star Lines.	Normal W. L.	Displacement.	Velocity.
4875.													
2	73·3385	6258	3399	...	...	...	...	...	...	...	...	...	...
2	72·8850	0812	8854	1111504	0459111	4200539	2630·595	4864·874	943	...	...	...	...
2	·7625	2008	7643	1112715	0463840	4195810	2627·731	4862·010	...	047	527	520	+32·08
1½	57·7995	1625	8020	1262338	1011756	3647894	2316·270	4550·549	...	386	766	620	40·85
2	·7600	2035	7617	1262741	1013143	3646507	2315·532	4549·811	642	...	...	...	...
2	53·0638	9015	0646	1309712	1171758	3487892	2232·489	4466·768	727	...	...	...	...
1½	52·9870	9765	9887	1310471	1174274	3485376	2231·195	4465·474	...	412	772	640	42·94
2	·4055	5582	4071	1316287	1193505	3466145	2221·338	4455·617	...	562	962	600	40·32
2	·2082	7605	2073	1318285	1200092	3459558	2217·970	4452·249	180	...	...	...	...
2	49·3580	6003	3623	1346735	1292822	3366828	2171·115	4405·394	...	391	908	483	32·84
4395.													
2	48·7390	2292	7384	...	...	...	...	...	...	...	...	...	...
2	·7635	1982	7661	1352697	1312005	3347645	2161·546	4395·825	...	826	426	400	27·28
2	45·9942	9685	9963	1380395	1400034	3259616	2118·125	4352·404	...	412	957	455	31·44
2	·2560	7080	2575	1387783	1423216	3236434	2106·898	4341·177	162	...	...	...	...
2	·2462	7095	2518	1387840	1423395	3236255	2106·810	4341·089	...	099	634	465	32·08
1½	44·2682	6958	2697	1397661	1454019	3205631	2092·007	4326·286	...	299	939	360	24·91
2	43·0715	8900	0742	1409616	1491008	3168642	2074·265	4308·544	...	560	023	537	37·37
3	42·0985	8695	0980	1419378	1520980	3138670	2059·999	4294·278	301	...	...	...	...
1	41·3328	6288	3355	1427003	1544249	3115401	2048·990	4283·269	...	285	722	563	39·00
2	40·5550	4030	5595	1434763	1567801	3091849	2037·909	4272·188	...	204	760	444	31·12
1½	39·7640	2005	7652	1442706	1591778	3067872	2026·689	4260·968	...	987	527	460	32·34
2	·7412	2280	7401	1442957	1592534	3067116	2026·336	4260·615	640	...	...	...	...
2	·0528	9075	0561	1449797	1613072	3046578	2016·776	4251·055	...	067	643	424	29·89
1½	37·8018	1632	8028	1462330	1650454	3009196	1999·491	4233·770	...	778	462	316	22·37
2	·3295	6320	3322	1467036	1664408	2995242	1993·077	4227·356	...	364	010	354	25·06
4202.													
2	35·457	5108	4567	...	...	...	...	...	...	...	...	...	...
1½	·20822	7565	2093	1488265	1726803	2932847	1964·648	4198·927	...	924	494	430	30·70

RADIAL VELOCITY—*Continued.*

2	34·6832	2745	9878	1493480	1741993	2917657	1957·788	4192·067	....	068	678	390	27·70
2	31·9600	0008	9631	1520727	1820512	2839138	1922·710	4156·989	....	989	623	366	26·35
2	30·9460	0135	9498	1530860	1849355	2810295	1909·983	4144·262	....	262	928	334	+24·11
2	27·3125	6570	3112	1567246	1951372	2708278	1865·640	4099·919	921	....	....	....	....

$\odot = 438°\ 27'.1$
$\triangle\odot \quad 33'.8$

$439°\ 00'.9$
$\lambda = 198°\ 01'.8$

$\odot - \lambda = 240°\ 59'.1$

log sin $(\odot - \lambda)$ 9·94175
log b 1·4193

1·36105
b sin $(\odot - \lambda)$ $-$ 22·96
c $+$ ·41

$V_s = +31·53$
$V_a = \quad -22·52$
$V_d = \quad -·04$
Curv. $= \quad -·28$

Radial Vel. $+$ 8·7
ϵ $\pm$ 5·85
ϵ_o $\pm$ 1·31

RADIAL VELOCITY.

Star η Boötis 812.
Date, June 10. 14^h 10^m
Hour angle, 30^m W.

Observer, J. S. P.
Measurer, W. E. H.
Computer, W. E. H.

Weight.	Micrometer Readings.		Means.	Corrected readings. Star lines.	Displacement in revolutions.	Velocity.
2	73·3385	6258	3399	......	......	......
2	72·8850	0812	8854	......	......	......
2	·7625	2008	7643	7928	·0207	+30·11
1½	57·7995	1625	8020	·8192	·0367	44·37
2	·7600	2035	7617	......	......	......
2	53·0638	9015	0646	......	......	......
1½	52·9870	9765	9887	·0120	0379	43·35
2	·4055	5582	4071	·4314	·0358	40·68
2	·2082	7605	2073	......	......	......
2	49·3580	6003	3623	·3923	·0294	32·29
2	48·7390	2292	7384	......	......	......
2	·7635	1982	7661	·7971	·0244	26·62
2	45·9942	9685	9963	·0320	·0289	30·59
2	·2560	7080	2575	......	......	......
2	·2462	7095	2518	·2885	·0304	31·92
1½	44·2682	6958	2697	·3084	·0230	23·95
2	43·0715	8900	0742	·1162	·0361	37·04
3	42·0985	8695	0980	......	......	......
1	41·3328	6288	3355	·3818	0391	39·37
2	40·5550	4030	5595	·6077	·0317	31·66
1½	39·7640	2005	7652	·8154	·0331	32·79
2	·7412	2280	7401	......	......	......
2	·0528	9075	0561	·1078	·0312	30·68
1½	37·8018	1632	8028	·8566	·0221	21·45
2	·3295	6320	3322	·3870	·0259	25·02
2	35·4572	5108	4567	......	......	......
1½	·2082	7565	2093	·2689	·0322	30·42
2	34·6832	2745	6878	·7486	·0287	26·98
2	31·9600	0008	9631	·0313	·0272	24·88
2	30·9460	0135	9498	·0213	·0250	+22·63
2	27·3125	6570	3112	......	......	......

$\odot = 438° \ 27'·1$
$\triangle\odot \quad 33·8$
$439° \ 00·9$
$\lambda = 198° \ 01·8$
$\odot - \lambda = 240° \ 59'·1$

log sin $(\odot - \lambda)$ 9·94175
log b 1·4193
$\overline{1}·36105$
b sin $(\odot - \lambda)$ —22·96
c + ·44

$V_s = +31·34$
$V_a =$ —22·52
$V_d =$ — ·04
Curv. = — ·28

Radial vel. +8·5

RADIAL VELOCITIES.

As mentioned in last year's report, the principal work undertaken with the spectrograph has been the determination of the radial velocities of stars and this work, except a few plates of the standard velocity stars given in last year's report, some plates of hydrogen stars and a few plates of Mira Ceti, a discussion of which is given below, has been confined to plates taken for the determination of the velocity curves and orbits of spectroscopic binaries. Of the 150 odd binaries so far discovered, only some 20 have had their orbits determined, and these have been chiefly of the solar type, which admit of accurate velocity determinations. About two-thirds of the binaries known are, however, stars of earlier type with few lines, often only the hydrogen series, which are in some cases diffuse. None of these stars admit of very accurate velocity determinations, and it is only in cases where the range of velocity is great and the corresponding percentage error small that accurate elements can be obtained. However, by increasing the number of observations and thereby obtaining mean values of the velocity for different phases in the orbit, fairly accurate values of the elements may be obtained in the stars with only a moderate range of velocity. It has been found necessary to carry out this procedure in the case of some of the binaries under observation, and so, although about six hundred spectra of 12 binary stars have been obtained, the necessity of obtaining in many stars a great number of plates and the impossibility of keeping the measuring and reducing up to date, have prevented more than one orbit being completed, although measurements have been made on several others.

Hence, as it seems useless to publish the measurements of those not finished, only those of α Draconis, which has been satisfactorily completed and of ι Orionis, of which preliminary elements have been obtained, will be here given, and the others which are under measurement, η Piscium, o Andromedae, α Corona Borealis, η Bootis, ϵ Herculis, δ Aquilae, θ Aquilae, η Virginis and γ Geminorum, will be given as soon as they are completed.

α *Draconis.*

α Draconis R. A. $14^h\ 1{\cdot}7^m$ Decl. + 64° 51′, Magnitude Visual 3·6, Photographic 4·0 was the first spectroscopic binary star to be observed here, the first plate being made on July 2, 1906, and the last on July 5, 1907. With the old Brashear spectroscope, 37 plates were made between July 2, 1906 and February 21, 1907, and with the new single prism spectrograph, 9 plates between May 22 and July 5, 1907. Of these plates, 45 have been measured, the other being rejected as unsuitable for measurement. All the measurement and reduction have been carefully and ably performed by Mr. W. E. Harper, assistant in spectrographic work. Some duplicate measures of plates giving large residuals from the velocity curve have been made by Mr. N. B. McLean and myself, but the velocity values except in the case of one plate have not been materially altered by the remeasurement.

The spectrum which is of Vogels Ia2 and Miss Maury's VIII a type possesses, in the measurable region with the Brashear instrument, generally only three lines Fe Ti 4549·642 Mg 4481·400 and $H\gamma$ 4340·634. In some of the spectra three or four other faint metallic lines are measurable. With the new single prism instrument in addition to the three above given H_β and H_δ and in strongly exposed plates $H\epsilon$ can also be accurately measured. Of these lines the Mg line is the best defined, and it is usually given about twice the weight of the others. Although about twice as many lines are obtainable with the new spectrograph as with the old, the linear dispersion is only three-fifths as great and the probable errors in the two cases are likely not much different from one another. The best criterion as to the relative accuracy of a single determination of the velocity is obtained from the residuals between the velocities computed from the elements of the orbit and the observed velocities. These give a probable error of $\pm 3{\cdot}4^{km}$ per second, while if three largely discrepant values are omitted it reduces to $\pm 2{\cdot}9^{km}$.

Considering the character of the spectrum and the dispersion employed, this result may be considered satisfactory and the determination of the elements probably as close as can be obtained from the observations. However, if many more observations were available a correction to the elements might be obtained, although it seems probable from the agreement already obtained that this would be small.

The data as regards the conditions of temperature, slit width, focus, &c., are given in the Record of Observations, which is followed by the measures of the different plates. The results of these measurements are collected in the table below from which the velocity curve is obtained.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Beginning.	Comparison Spectrum. End.	Comparison Spectrum. Kind.	Temperature. Room. Beginning.	Temperature. Room. End.	Temperature. Prism Box. Beginning.	Temperature. Prism Box. End.	Slit Width.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1906.	h. m.	m.	h. m.	s.	s.		Fahr.	Fahr.	Cent.	Cent.	m.m.						
α Draconis	321	..	Seed 27	July 2	16 20	60	4 20 W.	20	20	Fe. Spark.	68·0	66·8	23·9	23·9	·025	18·0	15·2	5·95	Fair	P	
″	328	....	″	″ 4	17 45	60	6 00 W.	17	17	″	58·3	56·3	21·4	21·4	·025	18·2	15·2	5·95	″	P	
″	376	....	Seed R.	Aug. 15	14 10	50	5 00 W.	20	20	″	71·2	69·2	26·0	26·1	·020	18·6	15·2	5·95	Good.	H	
″	381	....	″	″ 24	13 50	55	5 30 W.	15	15	″	66·2	65·5	23·2	23·1	·025	18·6	15·2	5·95	Fair	H	Clouds.
″	385	....	″	Sept. 5	15 30	60	7 55 W.	16	16	″	60·8	59·8	20·8	21·0	·025	12·4	15·2	5·68	Hazy.	H	
″	386	....	″	″ 6	13 50	75	6 30 W.	16	16	″	71·0	68·0	24·4	24·4	·025	18 6	15·2	5·68	″	H	
″	389	....	″	″ 10	14 15	60	7 00 W.	16	16	″	70·8	69·6	26·7	26·7	·025	15·0	15·2	5·75	Good.	H	
″	394	...	″	″ 19	13 35	75	7 00 W.	16	16	″	76·3	70·0	25·5	25·6	·025	20·0	15·2	5·75	″	H	
″	398	....	″	″ 27	13 10	60	7 00 W.	20	20	″	64·1	61·0	21·2	21·2	·025	15·0	15·2	5·70	″	H	Inclination ch'ng'd
″	404	....	Seed 27	Oct. 3	12 30	60	6 50 W.	20	20	″	64·0	62·0	21·1	21·1	·025	10·0	15·2	5·80	Hazy.	H	
″	412	....	″	″ 18	12 30	70	9 00 W.	25	25	″	54·0	52·0	16·4	16·4	·025	18·5	15·2	5·80	″	H	
″	416	....	″	Nov. 1	12 58	60	9 05 W.	20		″	40·5	38·5	8·6	8·7	·025	18·5	15·2	5·79	Good.	H	
″	417	....	″	″ 1	13 55	50	10 00 W.	25	25	″	38·5	37·5	8·7	8·6	·025	18·5	15·2	5·79	″	H	
″	418	....	″	″ 1	15 50	60	11 55 W.	20	20	″	36·0	35·7	9·3	9·1	·025	18·5	15 2	5·79	Fair	H	Low altitude.
″	422	....	″	″ 6	12 45	90	9 28 W.	25	25	″	44·2	42·2	12·1	12·0	·025	18·5	15·2	5·70	″	H	
″	423	...	″	″ 6	14 00	60	10 30 W.	25	25	″	42·2	41·2	12·0	12·1	.025	18·5	15 2	5·70	Good.	H	
″	424	....	″	″ 6	15 00	60	11 30 W.	25	25	″	41·2	40·0	12·1	12·0	·025	18·5	15·2	5·70	″	H	
″	426	....	″	″ 6	17 05	60	10 25 E.	25	25	″	39·0	38·4	11·1	11·1	·025	18·5	15·2	5·70	Fair	H	
″	428	....	″	″ 8	12 40	60	9 15 W.	25	25	″	41·7	39·7	9·6	9·7	·025	18·5	15·2	5·70	Good.	H	
″	429	...	″	″ 8	13 40	60	10 15 W.	25	25	″	39·7	38·0	9·7	9·8	·025	18·5	15·2	5·70	″	H	
″	430	....	″	″ 8	14 50	80	11 35 W.	25	25	″	38·0	36·5	9·8	9·7	·025	18·5	15·2	5·65	Fair	H	Hazy 15^{m}.
″	431	....	″	″ 8	16 00	60	11 25 E.	20	20	″	36·5	35·5	9·7	9·6	·025	18·5	15·2	5·65	″	H	
″	435	....	″	″ 16	14 10	50	11 10 W.	20	20	″	32·2	31·2	3·6	3·6	·037	18·5	15·2	5·72	Good.	P	
″	438	....	″	″ 19	13 15	90	10 45 W.	20	20	″	40·5	39·7	9·9	10·0	·030	18·5	15.2	5·72	Clo'dy	H	
″	447	....	″	Dec. 7	16 37	45	9 00 E.	20	20	″	— 2·0	-3·6	—19·1	—19·1	·030	19·0	15·2	5·60	...	P	
″	457	....	″	″ 11	18 40	50	6 40 E.	20	20	″	9·3	8·7	— 0·7	— 1·0	·033	19·0	15·2	5·68	Hazy.	H	
″	458	....	″	″ 13	13 27	50	11 50 E.	20	20	″	24·0	21·5	— 0·5	— 0·5	·037	19·0	15·2	5·75	.....	H	
″	462	...	″	″ 17	17 40	50	7 15 E.	25	25	″	16·8	17·2	— 6·2	— 6·2	·030	19·0	15·2	5·73	.....	P	
″	490	....	″	″ 18	17 05	50	7 50 E.	25	25	″	10·0	9·7	— 2·4	— 2·8	·037	19·0	15·2	5·73	......	H	
				1907.																	
″	524	....	″	Jan. 9	16 10	60	7 05 E.	20	20	″	8·4	8·0	—12·6	—12·5	·033	19·0	15·2	5 63	....	P	
″	528	....	″	″ 11	17 45	40	5 40 E.	20	20	″	10·0	10·2	—10·1	—10·1	·037	19 0	15·2	5·66	Fair	P	

RECORD OF SPECTROGRAMS.—*Continued.*

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Beginning.	Comparison Spectrum. End.	Comparison Spectrum. Kind.	Temperature. Room. Beginning.	Temperature. Room. End.	Temperature. Prism Box. Beginning.	Temperature. Prism Box. End.	Slit width in Millimetres.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1907.	h. m.	m.	h. m.	s.	s.		Fahr.	Fahr.	Cent.	Cent.							
a Draconis..	566	....	Seed 27..	Jan. 21	16 15	60	6 20 E.	20	20	Fe. spark.	6·2	4·3	—12·5	—12·6	·033	19·0	15·2	5·64	......	P	
" ..	593	....	" ..	" 30	17 02	56	4 55 E.	22	22	" ..	9·0	7·8	— 4·6	— 4·5	·037	19 0	15·2	5 67	......	H	
" ..	603	....	" ..	Feb. 6	18 02	55	3 30 E.	22	22	" ..	12·0	12·2	— 8·6	— 8·7	·030	20·5	15·2	5·65	......	P	
" ..	612	....	" ..	" 12	15 00	50	6 15 E.	22	22	" ..	6·8	7·3	— 9·0	— 8·8	·037	20·5	15·2	5·65	......	H	
											Centigrade										
" .	772	I.L.	" ..	May 22	20 23	30	5 30 W.	4-8-4		Fe. Vspark	9·5	8·9	13·4	13·5	·025	45·0	10·8	18·3	.....	P	Centigrade used from here on.
" ..	799	"	" ..	" 31	16 37	26	2 15 W.	2-2-2-2		" ..	14·6	13·5	18·9	18·9	·025	45·0	10·8	18·58	......	P	
" ..	809	"	" ..	June 8	18 50	30	5 05 W.	3-3-3-3		" ..	13·3	13·0	16·9	16·9	·025	45·0	10·8	18·58	......	P	
" ..	815	"	" ..	" 10	16 47	30	3 10 W.	2-2-2-2		" ..	14·0	13·5	17·8	17·8	·025	45·6	10·8	18·61	......	P	
" ..	823	"	" ..	" 11	14 17	35	0 47 W.	3-3-3-3		" ..	17·6	16·6	19·4	19·4	·025	45·6	10·8	18·61	......	H	
" ..	859	"	" ..	" 20	15 17	35	2 12 W.	3-4-8		" ..	22·6	21·4	25·7	25·7	·030	45·3	10·8	18·68	......	H	
" ..	870	"	" ..	" 21	16 36	38	3 45 W.	6-7-7-6		" ..	24·3	24·3	29·0	29·0	·025	47·7	10·8	18·63	......	P	
" ..	911	"	" ..	July 4	15 02	48	3 07 W.	4-4-4-4		" ..	21·5	20·0	29·0	29·0	·030	45·0	10·8	18·75	.....	H	
" ..	916	"	" ..	" 5	14 50	40	2 55 W.	2-5-3		" ..	22·6	21·2	26·4	26·4	·032	45·0	10·8	18·64	......	P	

α DRACONIS 321.

1906. July 2.
G. M. T. 16ʰ 20ᵐ

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
3	S 70·0713	4549·642	....	....	....	....
1	70·0979	4549·956	·956	·642	·314	+20·66
3	65·2872	4494·786	....	·738	....	....
3	64·0885	4481·577	·557	·400	·157	+10·50
2	63·5923	4476·168	....	·185	....	....
2	S 56·7442	4404·927	....	....	....	....
2	54·5836	4383·688	....	·720	....	....
½	52·9892	4368·373	·403	·071	·330	+22·63
3	S 48·4045	4325·939	....	....	....	....
3	40·8267	4260·615	....	·640	....	....
1	37·4777	4233·490	·498	·328	·170	+12·03

Weighted mean	+13·73
V_a	—9·73
V_d	— ·10
Curvature	— ·50
Radial velocity	+ 3·4

α DRACONIS 328.

1906. July 4.
G. M. T. 17ʰ 45ᵐ.

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
2	70·2010	4549·557	....	·642	....	....
3	S 68·4274	4528·798	....	....	....	....
2	65·4225	4494·732	....	·738	....	....
3	64·2438	4481·734	·764	·400	·264	+24·35
1	63·7297	4476·127	....	·185	....	....
3	S 56·8874	4404·927	....	....	....	....
2	54·7276	4383·695	....	·720	....	....
2	50·2072	4341·035	·045	·634	·411	+28·35
3	S 48·5469	4325·939	....	....	....	....
3	46·5476	4308·152	....	·081	....	....

Weighted mean	+25·95
V_a	—9·48
V_d	— ·15
Curvature	— ·50
Radial velocity	+ 15·8

α DRACONIS 376.

1906. Aug. 15.
G. M. T. 14h 10m.

Observed by }
Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
1	70·2400	4549·622	....	·642	....	....
3	70·2117	4549·287	·247	·642	·395	−26·04
3	S 68·4580	4528·798	....	....	....	....
2	65·4466	4494·712	....	·738	....	....
3	64·2008	4481·002	·012	·400	·388	−25·95
2	63·7596	4476·199	....	·185	....	....
2	62·8784	4466·689	....	·727	....	....
3	S 56·9013	4404·927	....	....	....	....
2	54·7324	4383·683	....	·720	....	....
2	50·1100	4340·087	·127	·634	·507	−34·98
3	S 48·5513	4325.939	....	....	....	....
3	46·5436	4308·093	....	·081	....	....

Weighted mean		−28·24
V_a	−2·69	
V_d	— ·15	
Curvature	— ·50	
Radial velocity		−31·6

α DRACONIS 381.

1906. Aug. 24.
G. M. T. 13h 50m

Observed by }
Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	72·8078	4583·992	....	·018	....	....
½	69·9561	4549·566	....	·642	....	....
1	69·9851	4549·909	·869	·642	·227	+14·95
3	S 68·1809	4528·798	....	....	....	....
2	65·1680	4494·695	....	·738	....	....
3	63·9714	4481·466	·496	·400	·096	+6·42
1	63·4880	4476·196	....	·185	....	....
2	62·6072	4466·678	....	·727	....	....
3	S 56·6392	4404·927	....	....	....	....
2	54·4785	4383·681	....	·720	....	....
2	49·9290	4340·739	·719	·634	·085	+6·55
3	48·3088	4325·982	....	·939	....	....
3	S 46·2960	4308·081	....	....	....	....

Weighted mean		+7·88
V_a	−0·92	
V_d	− ·15	
Curvature	− ·50	
Radial velocity		+6·3

α DRACONIS 385

1906. Sept. 5.
G. M. T. 15h 30m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	63·7726	4528·806	....	·798	....	....
2	S 60·7656	4494·738	....	....	....	....
1	59·5384	4481·214	·200	·400	·200	−13·38
1	59·0801	4476·218	....	·185	....	....
1	58·2004	4466·710	....	727	....	....
2	S 52 2319	4404·927	....	....	....	....
2	S 43·9037	4325·939	....	....	....	....

Velocity....................................		−13·38
V_a	+1·53	
V_d		− ·15
Curvature....................		− ·50
Radial velocity..............................		−12·5

Note.—Hγ is not set at micrometer reading 50·0000 as usual.

α DRACONIS 386

1906. Sept. 6.
G. M. T. 13h 50m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	S 68·1702	4528·798	....	....	....	....
½	65·1659	4494·731	....	·738	....	....
2	63·9349	4481·156	·170	·400	·230	−15·39
1	63·4777	4476·170	....	·185	....	....
1	62·5983	4466·658	....	·727	....	....
3	S 56·6347	4404·927	....	....	....	....
3	48·2985	4325·928	....	·939	....	....
3	S 46·2942	4308·081	....	....	....	....

Velocity....................................		−15·39
V_a	+1·70	
V_d		− ·16
Curvature....................		− ·50
Radial velocity..............................		−14·3

α DRACONIS 389.

1906. Sept. 10.
G. M. T. 14h 15m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
2	70·1700	4549·634	....	·642	....	....
2	70·1237	4549·088	·096	·642	·546	—35·98
3	S 68·3865	4528·798	....	....	....	....
½	65.3676	4494·630	....	·738	....	....
2	64·1289	4480·995	·000	·400	·400	—27·60
2	62·8095	4466·709	....	·727	....	....
1	57·8697	4415·294	....	·293	....	....
3	S 56·8356	4404·927	....	....	....	....
2	54·6829	4383·761	....	·727	....	....
2	50·0654	4340·180	·164	·634	·470	—32·43
3	S 48·5000	4325·939	....	....	....	....
3	46·4936	4308·064	....	·081	....	....

Weighted mean..................		— 32·00
Va	+ 2·53	
Vd		— ·15
Curvature...............		— ·50
Radial velocity................		— 30·1

α DRACONIS 394.

1906. Sept. 19.
G. M. T. 13h 35m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
2	*70·0925	4549·642	....	·642	....	....
1	*70·0405	4549·017	·017	·642	·625	—41·14
3	S 68·4238	4528·798	....	....	....	....
2	65·4129	4494·677	....	·738	....	....
3	64·1348	4480·597	·640	·400	·760	—50·84
2	63 7285	4476·169	....	·185	....	....
2	62·8504	4466·681	....	·727	....	....
3	S 56·8823	4404·927	....	....	....	....
2	54·7233	4383·697	....	·720	....	....
½	50·1287	4340·337	·344	·634	·290	—20·00
3	48·5450	4325·935	....	·939	....	....
3	S 46·5397	4308·081	....	....	....	....

Weighted mean..................		— 45·26
Va	+ 4·27	
Vd		— ·15
Curvature...............		— ·50
Radial velocity................		— 41·6

Not used in first measurement.

α DRACONIS 398.

1906. Sept. 27.
G. M. T. 13h 10m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
3	S 65·3536	4494·738	....	....	....	....
2	64·0960	4480·863	800	·400	·600	—40·14
3	63·6737	4476·254	....	·185	....	....
2	62·7994	4466·793	....	·727	....	....
3	S 56·8297	4404·927	....	....	....	....
2	54·6765	4383·720	....	·720	....	....
3	50·0377	4339·876	·874	·634	·760	—52·44
3	S 48·5075	4325·939	....	....	....	....
3	46·5037	4308·065	....	·081	....	....

Weighted mean............		— 47·52
V_a	+ 5·75	
V_d		— ·15
Curvature............		— ·50
Radial velocity............		— 42·4

α DRACONIS 404.

1906. Oct. 3.
G. M. T. 12h 30m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
3	S 68·3345	4528·798	....	....	....	....
2	65·3395	4494·748	....	·738	....	....
2	*70·1183	4549·743	....	·642	....	....
1	*70·0688	4549·154	·052	·642	·590	−36·24
3	64·0699	4480·719	·670	·400	·730	−48·83
2	63·6618	4476·260	....	·185	....	....
2	62·7866	4466·776	....	·727	....	....
3	S 56·8227	4404·927	....	....	....	....
3	S 48·4953	4325·939	....	....	....	....

Weighted mean............		−45·68
V_a	+ 6·84	
V_d		− ·15
Curvature............		− ·50
Radial velocity............		− 39·5

*Not used in first measurement.

α DRACONIS 412.

1906. Oct. 18.
G. M. T. 12h 30m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
1	69·——	4550·011	·011	·642	·369	+24·71
3	S 68·3213	4528·798	....	....	....	....
2	65·3250	4494·694	....	·738	....	....
1	64·1560	4481 751	·750	·400	·350	+23·41
1	63·6515	4476·225	....	·185	....	....
2	62·7761	4466·723	....	·727	....	....
3	S 56·8302	4404·927	....	....	....	....
3	S 48·5299	4325.939	....	....	....	....

Weighted mean........................ +23·84
V_a...... .... + 9·16
V_d........................ − ·12
Curvature................ − ·50

Radial velocity.................... +32·4

α DRACONIS 416.

1906. Nov. 1.
G. M. T. 13h

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.
1	69 9793	4549·632	.... .	·642	....	....
½	69·9081	4548·784	·792	·642	·850	−55·93
3	S 68·2089	4528·798	....	....	....	....
1	65·2177	4494·765	....	·738	....	....
2½	63·9462	4480·618	650	·400	·750	−50·18
1	62·6689	4466·703	....	·727	....	....
3	S 56·7304	4404·927	....	....	....	....
2	54·5828	4383·703	....	·720	....	....
1	49·9510	4339·793	·804	·634	·830	−57·27
3	S 48·4341	4325·939	....	....	....	....
3	46·4368	4308·075	....	·081	....	....

Weighted mean.......... .. .. −52·67
V_a......... ...... +10·76
V_d.. .... − ·12
Curvature.................. − ·61

Radial velocity.. .... −42·6

α DRACONIS 417.

1906. Nov. 1.
G. M. T. 14h

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	70·0521	4549·640	....	·642	....	....
½	69·9868	4548·863	·862	·642	·780	−51·32
3	S 68·2795	4528·798	....	....	....	....
2	65·2918	4494·768	....	·738	....	....
1	64·0208	4480·694	·680	·400	·720	−48·16
1	63·6034	4476·123	....	·185	....	....
1	62·7386	4466·729	....	·727	....	....
3	S 56·7968	4404·927	....	....	....	....
2	54·6519	4383·725	....	·720	....	....
½	50·0302	4339·885	·884	·634	·750	−51·75
3	S 48·5042	4325·939	....	....	....	....
3	46·5071	4308·061	....	·081	....	....

Weighted mean....................		− 49·84
V_a..............	+ 10·76	
V_d..............		− ·10
Curvature..................		− ·50
Radial velocity..................		− 39·8

α DRACONIS 418.

1906. Nov. 1.
G. M. T. 15h 50m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	72·8817	4584·216	....	·018	....	....
1	72·1993	4575·801	·702	·512	·810	−52·97
1	71·3441	4565·369	·249	·842	·593	−38·84
2	70·0434	4549·735	....	·642	....	....
2	69·9815	4548·998	·942	·642	·700	−46·06
3	S 68·2644	4528·798	....	....	....	....
2	65·2796	4494·778	....	·738	....	....
3	64·0156	4480·773	·730	·400	·670	−44·82
1	63·6044	4476·267	....	·185	....	....
2	62·7263	4466·725	....	·727	....	....
1	62·6559	4465·965	·927	·727	·800	−53·68
½	62·5824	4465·172	·135	·975	·840	−56·36
3	S 56·7851	4404·927	....	....	....	....
2	54·6416	4383·747	....	·720	....	....
½	50·0281	4340·011	·014	·634	·620	−42·78
3	S 48·4871	4325·939	....	....	....	....
3	46·4865	4308·051	....	·081	....	....

Weighted mean....................		− 46·84
V_a..............	+ 10·79	
V_d..............		− ·04
Curvature..................		− ·50
Radial velocity..................		− 36·6

α DRACONIS 426.

1906. Nov. 6.
G. M. T. 17h 05m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	69·8776	4549·574	....	·642	....	....
1	68·4960	4533·301	·305	·139	·834	−55·12
3	S 68·1090	4528·798	....	....	....	....
2	65·1115	4494·687	....	·738	....	....
2	63·8352	4480·568	·590	·400	·810	−54·18
2	63·4353	4476·193	....	·185	....	....
1	62·5608	4466·702	....	·727	....	....
3	S 56·6151	4404·927	....	....	....	....
1	54·4642	4383·691	....	·720	....	....
½	49·8568	4340·042	·058	·634	·576	−39·74
3	48·3115	4325·936	....	·939	....	....
3	S 46·3141	4308·081	....	....	....	....

Weighted mean		− 52·38
V_a	+ 11·21	
V_d	+ ·04	
Curvature		− ·50
Radial velocity		−41·6

Note.—Other lines in this spectrum, unidentified as yet.

α DRACONIS 424.

1906. Nov. 6.
G. M. T. 15h

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	72·7892	4584·099	....	·018	....	....
½	72·6984	4583·978	·938	·018	1·080	−70·41
2	S 69·9459	4549·642	....	....	....	....
1½	69·8710	4548·752	·752	·642	·890	−58·65
3	68·1710	4528·799	....	·798	....	....
2	65·1727	4494·693	....	·738	....	....
3	63·8975	4480·592	·590	·400	·810	−54·18
2	63·4975	4476·217	....	·185	....	....
2	62·6202	4466·701	....	·727	....	....
2	S 56·6725	4404·927	....	....	....	....
1	54·5237	4383·719	....	·720	....	....
1	49·8738	4339·691	·694	·634	·940	−64·86
2	S 48·3665	4325·939	....	....	....	....
2	46·3662	4308·064	....	·081	....	....

Weighted mean		− 58·43
V_a	+ 11·20	
V_d		− ·04
Curvature		− ·50
Radial velocity		−47·8

α DRACONIS 423.

1906. Nov. 6.
G. M. T. 14h

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	72·7646	4584·216	....	·018	....	....
1	72·6892	4583·283	·118	·018	·900	−58·68
2	69·9150	4549·655	....	·642	....	....
1	69·8431	4548·800	·792	·642	·850	−56·01
3	S 68·1400	4528·798	....	....	....	....
2	65·1516	4494·787	....	·738	....	....
3	63·8659	4480·565	·525	·400	·875	−58·53
2	63·4695	4476·227	....	·185	....	....
1	62·5938	4466·726	....	·727	....	....
3	S 56·6442	4404·927	....	....	....	....
2	54·4961	4383·729	....	·720	....	....
½	49·8607	4339·848	.854	·634	·780	−53·82
3	48·3347	4325·931	....	·939	....	....
3	S 46·3360	4308·081	....	....	....	....

Weighted mean....................		− 57·57
V_a.............	+ 11·20	
V_d........................		− ·09
Curvature................		− ·50
Radial velocity..............................		−47·0

α DRACONIS 422.

1906. Nov. 6.
G.M.T. 12h 45m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
3	S 68·2300	4528·798	....	....	....	....
2	65·2341	4494·700	....	·738	....	....
2	63·9604	4480·608	·620	·400	·780	−52·18
2	63·5566	4476·190	....	·185	....	....
2	62·6820	4466·699	....	·727	....	....
3	S 56·7361	4404·927	....	....	....	....
3	S 48·4300	4325·939	....	....	....	....

Velocity........................		— 52·18
V_a..............	+ 11·19	
V_d.......................		— ·11
Curvature..................		— ·50
Radial velocity..............................		— 41·6

α DRACONIS 428.

1906. Nov. 8.
G.M.T. 12h 40m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	69·9312	4549·735	....	·642	....	....
1	69·8497	4548·766	·692	·642	·950	—62·60
3	S 68·1502	4528·798	....	....	....	....
2	65·1595	4494·747	....	·738	....	....
2	63·8742	4480·523	·510	·400	·890	—59·54
2	63·4790	4476·197	....	·185	....	....
2	62·6002	4466·659	....	·729	....	....
3	S 56·6599	4404·927	....	....	....	....
2	54·5105	4383·705	....	·720	....	....
½	49·8531	4339·598	·604	·634	1·030	—71·07
3	48·3558	4325·937	....	·939	....	....
3	S 46·3577	4308·081	....	....	....	....
½	46·2693	4307·301	·301	·081	·780	—54·21

Weighted mean........................		— 61·09
V_a	+ 11·35	
V_d	—	·11
Curvature..........	—	·50
Radial velocity.........		— 50·3

α DRACONIS 429.

1906. Nov. 8.
G.M.T. 13h 40m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
2	70·1414	4549·709	....	·642	....	....
½	70·0718	4548·881	·832	·642	·810	—53·37
3	S 68·3617	4528·798	....	....	....	....
1	65·3712	4494·765	....	·738	....	....
2	64·0896	4480·586	·580	·400	820	—54·85
1	63·6846	4476·155	....	·185	....	....
2	62·8133	4466·698	....	·727	....	....
3	S 56·8672	4404·927	....	....	....	....
1	*50·1845	4340·752	·750	·530	·780	—53·82
3	S 48·5620	4325·939	....	....	....	....

Weighted mean........................		— 54·22
V_a	+ 11·35	
V_d	—	·09
Curvature..........	—	·50
Radial velocity...		— 43·5

* A sharp line showing in the diffuse Hγ band.

α DRACONIS 430.

1906. Nov. 8.
G. M. T. 14h 50m

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8957	4584·126	....	·018	......	.. ..	2	63·6049	4476·129	....	·185	....	....
1	72·8267	4583·150	·068	·018	·950	−61·94	2	62·7401	4466·739	....	·727	......	....
1	71·8211	4570·928	·889	·849	·960	−62·88	3	S 56·7940	4404·927	....	......	......	....
2	S 70·0539	4549·642	....	.. ..	......	....	2	54·6446	4383·698	....	·720	.....	....
1	69·9830	4548·798	.782	·642	·860	−56·42	1	49·9985	4339 681	·680	·640	·960	−66·24
3	68·2857	4528·850	....	·798	......	....	3	48·4942	4325·950	...	·939	.....	....
2	65·2942	4494·781	....	·738	....	....	3	S 46·4954	4308·081	....	......	... .	....
3	64·0222	4480·698	·670	·400	·730	−48·83							

Weighted Mean........................		−56·27
V_a	+ 11·35	
V_d		− ·04
Curvature...................		− ·50
Radial Velocity		−45·5

α DRACONIS 431.

1906. Nov. 8.
G. M. T. 16h

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	70·0770	4549·657	....	·642	... .	....	1	61·9930	4458·602	·586	·301	·715	−48·05
1	70·0138	4548·907	·896	·642	.746	−49·16	3	S 56·7999	4404·927	. ..	......	......	....
1	69·2565	4539·964	·958	·772	·814	−53·72	2	54·6515	4383·723	...	·720	.....	....
1	68·6867	4533·296	·294	·134	·845	−55·85	1½	50·0245	4339·887	·894	·634	·740	−51·06
2	S 68·2999	4528·798	....	.....	... .	....	3	48·4955	4325·928	....	·939	....	....
1	65·3091	4494·788	....	·738	......	... .	3	S 46·4995	4308·081	....	.....	......	....
3	64·0232	4480·570	·570	·400	·830	−55·52	½	37·5207	4232·679	·678	·328	·650	−46·02
1	63·6216	4476·179	....	·185	......	....	1	37·9485	4236·101	....	·112	....	....
1	62·7521	4466.749	..	·727	......	... .							

Weighted Mean.................		−52·55
V_a	+ 11·35	
V_d		·00
Curvature		− ·50
Radial Velocity....		−41·7

α DRACONIS 435.

1906. Nov. 16
G. M. T. 15ʰ 32ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
1	72·7836	4583·895	....	·018	......	....	½	63·4899	4476·076	...	·185	.....	....
½	72·7171	4583·075	·178	·018	·840	−54·76	2	S 56·6805	4404·927	....	.....	.....	....
1	69·9458	4549·544	....	·642	.	....	1	54·5351	4383·736	....	·720	.....	....
1	69·8785	4548·745	·792	·642	·850	−56·01	½	49·8815	4339·616	·592	·640	1·048	−72·31
2	S 68·1778	4528·798	....	......	......	....	2	48·3863	4325·952	....	·939	....	....
1	65·1776	4494·687	....	·738	......	....	2	S 46·3903	4308·081	...	......	.....	....
3	63·8822	4480·366	·460	·400	·940	−62·88							

Weighted Mean............		−61·63
V_a	+11·82	
V_d	−	·04
Curvature.........	−	·50
Radial Velocity............		....−50·3

α DRACONIS 438.

1906. Nov. 19.
G. M. T. 13ʰ 15ᵐ

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
1	70·0752	4549·633	....	·642	......	....	1	62·7500	4466·668	...	·727	......	....
1	69·9975	4548·708	·712	·642	·930	−61·28	3	S 56·8075	4404·927	....	.....	....	....
3	S 68·3017	4528·798	....	......	...	....	2	54·6582	4383·706	....	·720	......	....
2	65·3075	4494·722	....	·738	.....	....	2	50·0056	4339·640	·650	·640	·990	−68·31
3	64·0136	4480·414	·440	·400	·960	−64·22	2	48·5047	4325·936	....	·939	......	....
2	63·6254	4476·166	....	·185	......	....	2	S 46·5067	4308·081	....	....	......	....

Weighted Mean...........		−65·09
V_a	+11·94	
V_d	−	·09
Curvature..........	−	·50
Radial Velocity................		−53·7

α DRACONIS 447

1906 Dec. 7
G. M. T. $16^h 37^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	70·0639	4549·943	·895	·642	·253	+16·67	2	62·7195	4466·677	...	·727	....	....
2	70·0427	4549·692	....	·642	......	....	3	S 56·7810	4404·927	...	....	.....	....
3	S 68·2658	4528·798	...	......	...	....	2	54·6345	4383·718	....	·720	....	....
3	65·2792	4494·783	...	·738	......	....	2	50·1348	4341·028	·034	·634	·400	+27·60
3	64·0944	4481·657	630	·400	·230	+15·38	3	48·4832	4325·931	....	·939	..	....
1	63·6035	4476·277	...	·185	....	....	3	S 46·4880	4308·081	....	....	.....	....

Weighted Mean	+19·67	
V_a	+11·94	
V_d	+ ·10	
Curvature........		− ·50
Radial velocity..................		+31·2

α DRACONIS 457

1906 Dec. 11
G. M. T. $18^h 40^m$

Observed by / Measured by } W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	70·0572	4549·960	·962	·642	·320	+21·08	2	62·6839	4466·704	....	·727	......	....
2	70·0301	4549·638	....	·642	......	....	3	S 56·7199	4404·927	....	......	....	....
3	S 68·2502	4528·798	....	.....	.....	....	½	50·0392	4340·933	·934	·634	·300	+29·70
1	66·4960	4508·737	·735	·455	·280	+18·62	3	48·3915	4325·925	....	·939	......	....
2	64·0671	4481·715	·700	·400	·300	+20·07	3	S 46·3900	4308·081	..	.....	.....	....
1	63·5640	4476·224	....	·185	......	....							

Weighted Mean............	+20·04	
V_a	+11·78	
V_d	+ ·15	
Curvature........		− ·50
Radial velocity		+31·5

α DRACONIS 457*

1906. Dec. 11.
G. M. T. $18^h\ 40^m$

Observed by W. E. HARPER.
Measured by J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1½	70·0592	4549·615	...	·642	......	......	1	63·5910	4476·178	....	·185	......	....
½	70 0839	4549·908	·938	·642	·296	+19·51	2	56·7495	4404 912	....	·927	......	....
2	68·2755	4528·731	....	·798	...	....	$\frac{1}{10}$	50·08	4341·030	·038	·634	·404	27·92
¼	66·5167	4508·620	·680	·455	·225	14·96	3	48·4238	4325·936	....	·939	....	......
2	65·2717	4494·663	....	·738	.....	....	½	48·4486	4326·160	·163	·939	·224	+15.52
2	64·0914	4481·649	·701	·400	·301	20·14	2	46·4179	4308·053	....	·081	.....	....

Weighted mean.............	+19·20
V_a	+11·78
V_d	+ ·15
Curvature.. −·50	
Radial velocity.......	+30·6

*Check measurement.

α DRACONIS 457.*

1906. Dec. 11.
G. M. T. $18^h\ 40^m$

Observed by W. E. HARPER.
Measured by N. B. McLEAN.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	70·1115	4550·218	·306	·642	·664	+43·76	2	62·7089	4466·623	....	·727	.....	....
2	70·0508	4549·546	....	·642	... .	....	3	56·7509	4404·912	....	·927	.....	....
3	68·2784	4528·748	....	·798	......	....	¼	50·0562	4340·791	·819	·634	·185	+12·78
1	66·5236	4508·681	·737	·455	·282	18·75	3	48·4200	4325·889	....	·939	......	....
2	64·0900	4481·610	·658	·400	·258	17·26	3	46·4195	4308·054	....	·081	.. ..	....
1	63·5898	4476·151	....	·185	. ....	....							

Weighted mean............. .	+27·42
V_a	+11·78
V_d	+ ·15
Curvature.. −·50	
Radial velocity...	+38·5

* Check measurement

α DRACONIS 458.

1906. Dec. 13.
G. M. T. 13h 27m

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
1	70·1807	4550·120	·129	·642	·487	+32·09	2	62·7824	4466·669	...	·727	....	......
2	70·1390	4549·628	..	·642	.....	....	3	S 56·8145	4404·927	....	......	....	....
3	S 68·3582	4528·798	...	......	......	....	2	54·6584	4383·729	....	·720	..	....
2	65·3567	4494·790	....	·738	......	....	½	50·1363	4341·035	·019	·634	·385	+26·91
3	64·1686	4481·695	·685	·400	·285	+19·06	3	48·4796	4325·963	....	·939	....	....
2	63·6704	4476·263	....	·185	.....	......	3	S 46·4711	4308·081	....	.....	......	....

Weighted mean........	+22·83	
V_a	+11·68	
V_d	·00	
Curvature		− ·50
Radial velocity		+34·0

α DRACONIS 462.

1906. Dec. 17.
G. M. T. 17h 40m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	70·0536	4549·678	....	·642	.....	....	2	62·7087	4466·666	....	·727	.....	....
½	70·0424	4549·544	·512	·642	·130	−8·56	3	S 56·7532	4404·927	....	.....	......	....
3	S 68·2726	4528·798	....	......	......	....	3	54·5990	4383·707	....	·720	...	....
3	65·2756	4494·766	....	·738	...	....	1½	50·0332	4340 529	514	·634	·120	−8·28
4	64·0368	4481·087	·060	·400	·340	−22·74	2	48·4342	4325·971	....	·939	.....	....
3	63·5915	4476·224	....	·185	...	....	3	S 46·4282	4308·081	...	..	......	....

Weighted mean........		−17·94
V_a	+11·42	
V_d	+ ·15	
Curvature...........		− ·50
Radial velocity.. ...		−6·9

α DRACONIS 490.

1906. Dec. 18
G. M. T. 18ʰ 5ᵐ

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	70·0805	4549·626	...	·642	....	....	1	62·7312	4466·717	....	·727	......	....
½	70·0339	4549·075	·092	·642	·550	− 36·24	3	S 56·7629	4404·927	....	......	......	....
3	S 68·3005	4528·798	....	. . .	......	....	2	54·6054	4383 694	....	·720	......	....
2	65·2975	4494·765	.. .	·738	....	....	½	49·9881	4340·083	·084	·634	·550	− 37·95
3	64·0505	4481·019	·020	·400	·380	− 25·42	3	48·4366	4325·959	....	·939	......	....
2	63·6060	4476·174	....	·185	....	....	3	S 46·4310	4308·081	....	......	... ..	....

Weighted mean....		− 28·34
V_a..........	+11·35	
V_d............	+ ·14	
Curvature.....		− ·50
Radial velocity....		− 16·8

α DRACONIS 524.

1907. Jan. 9
G. M. T. 16ʰ 10ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	70·0357	4549·479	....	·642	......	....	2	62·7148	4466·725	....	·727	......	....
1	69·9853	4548·881	·992	·642	·650	− 42.83	3	S 56·7590	4404·927	...	. .	......	....
3	S 68·2714	4528·798	....	....	....	....	2	54·6102	4383·733	. . .	·720	.. ...	....
2	65·2685	4494·693	..	·738	. ...	....	2	49·9830	4339·930	·904	·634	·730	− 50·37
3	63·9895	4480·571	·570	·400	·830	− 55·52	3	48·4527	4325·967	....	·939	......	....
2	63·5907	4476·214	....	·185	......	....	3	S 46·4514	4308·081	...	......	......	....

Weighted mean....		− 51·69
V_a.......... .	+ 8·94	
V_d..........	+ ·15	
Curvature. ...		− ·50
Radial velocity..		− 43·1

a DRACONIS 528.

1907. Jan. 11.
G. M. T. 17h 45m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W.L.	Displacement.	Velocity
S 3	65·3082	4494·738	....	...	.....	....	1	54·6475	4383·776	....	·720	....	....
2	64·0390	4480·721	·700	·400	·700	−46·83	2	50·0264	4340·055	·044	·634	·590	−40·71
2	63·6273	4476·224	....	·185	.....	....	3	48·4764	4325·925	...	·939	. .	....
2	62·7546	4466·770	....	·727	......	....	S 3	46·4778	4308·081	....	......	......	... ...
S 2	56·7930	4404·927	....	.....	.....	....							

Weighted Mean		−43·79
V_a	+ 8·63	
V_d	+ ·16	
Curvature..		− ·50
Radial Velocity..................		−35·5

a DRACONIS 566.

1907. Jan. 21.
G. M. T. 16h 15m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W.L.	Displacement.	Velocity
2	70·0520	4549·443	....	·642	. . .	... .	3	56·7706	4404·972	....	·927	......	....
1	70·0481	4549·397	·592	·642	·050	— 3·29	2	50·0527	4340·613	·434	·634	·200	−13·80
2	65·2711	4494·536	....	·738	......	....	3	48·4670	4326·154	....	·939	......	....
3	64·0499	4481·060	·160	·400	·240	—16·05	3	46·4677	4308·335	....	·081	......	....
2	63·5975	4476·122	....	·185	......	....							

Weighted Mean........		−13·17
V_a	+ 7·03	
V_d	+ ·15	
Curvature..		− ·50
Radial Velocity.................		− 6·5

α DRACONIS 593.

1907. Jan. 30.
G. M. T. 17ʰ 02ᵐ

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·2447	4494·574	....	·738	......	....	2	50·0820	4341·193	·234	·634	·600	+41·40
3	64·0911	4481·840	·950	·400	·550	+36·79	3	48·4028	4325·896	....	·939	.....	....
2	63·5662	4476·110	....	·185	......	....	3	46·4055	4308·091	....	·081	......	....
3	56·7275	4404·863	....	·927	......	......							

Weighted Mean......		+38·63
V_a		+ 5·38
V_d		+ ·15
Curvature..... .	− ·50	
Radial Velocity...............		+43·7

α DRACONIS 603.

1907. Feb. 6.
G. M. T. 18ʰ 02ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	70·0599	4549·656	....	·642	.....	....	2	54·6360	4383·838	....	·720	......	....
1	70·0490	4549·527	·512	·642	·130	− 8·56	2	50·0753	4340·652	·554	·634	·080	5·52
1	65·2891	4494·781	.. .	·738	....	....	3	48·4740	4326·042	....	·939	.. ...	....
3	64·0707	4481·314	·275	·400	·125	8·36	3	46·4750	4308·186	. ..	·081	....	....
1	63·6050	4476·222	....	·185	......	....	1	46·4605	4308·058	·961	·081	·120	− 8·35
3	56·7826	4405·012	....	·927	.....	......							

Weighted Mean......		− 7·58
V_a	+ 4·01	
V_d	+ ·14	
Curvature........		− ·50
Radial Velocity.........................		− 3·9

α DRACONIS 612.

1907. Feb. 12.
G. M. T. 15^h

Observed by } W. E. HARPER.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
1	70·5547	4555·551	·622	·202	·580	−38·17	3	64·0239	4480·801	·740	·400	·660	44·15
2	70·0516	4549·558	....	·642	.....	....	2	63·6090	4476·266	....	·185	.....	....
1	70·0155	4549·129	·202	·642	·440	28·95	3	56·7835	4405·020	....	·927	.....	....
1	68·6833	4533·462	·479	·139	·660	43·62	2	50·0368	4340·298	·154	·634	·480	−33·12
3	68·2827	4528·805	...	·798	.....	....	3	48·4795	4326·092	...	·939	.....	....
2	65·2884	4494·774	....	·738	.....	....	3	46·4821	4308·250	...	·081	......	....

Weighted mean........	− 38·76
V_a...	+ 2·84
V_d........	+ ·15
Curvature.........	− ·59
Radial velocity...	− 36·0

α DRACONIS 772.

1907. May 22.
G. M. T. $20^h 23^m$

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	78·6890	4880·625	......	1·745	...	....	1	62·8200	4549·503	9·542	9·642	·100	6·59
2	77·8348	4860·425	1·422	1·527	·105	− 6·48	1½	58·3070	4469·851	......	9·873	...	....
1½	77·4210	4850·750	.....	1·686	....	....	2	50·2595	4340·540	0·540	0·634	·094	6·48
1½	75·3228	4802·762	.....	3·072	....	....	2	49·2883	4325·930	....	5·939	....	....
S 2	61·6768	4528·798	....	.....	....	....	S 3	54·3854	4404·927	....	..	....	....
2	59·7517	4494·751	....	4·738	....	... .	1¾	47·1338	4294·228	4·233	4·273	·040	− 2·80
2	58·9758	4481·310	1·310	1·400	·090	6·02	S 2	44·7783	4260·640	.....	....	...	....
2	62·8255	4549·602	......	9·642	....	....							

Weighted mean.............	− 5·67
V_a......	−11·73
V_d	− ·15
Curvature...............	− ·28
Radial velocity..............	−17·8

α DRACONIS 799

1907. May 31.
G. M. T. $16^h\ 37^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	73·6686	4881·512	......	1·745	....	....	1½	54·7212	4494·816	... .	4·738	....	....
2	73·2481	4871·441	......	1·453	....	....	2½	53 9315	4481·118	1·050	1·400	·350	23·41
2	72·8110	4861·197	1·207	1·527	·320	−19·58	1	53·2791	4469·926	.....	9·871	....	....
1½	57·7965	4549·772	......	9·642	...	.. ..	2	45·2691	4341·004	......	1·162	....	....
1½	57·7735	4549·352	9·222	9·642	·420	27·67	2	45·2025	4339·995	0·154	0·634	·480	−33·12

Weighted Mean..	−25·94
V_a	−11·75
V_d	− ·09
Curvature......	− ·28
Radial velocity............	− 38·1

α DRACONIS 809

1907. June 8.
G. M. T. $18^h\ 50^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity
2	72·9591	....	....	....	2	45·2871	. . ..	....	.. ..
2	72·7925	·7957	·0230	−33·73	2	45·2251	·2217	·0270	28·35
1½	72·3971	....	....	....	½	27·4655	·4591	·0374	−39·27
2	54·0231	....	....	....	2	27·3286	....	....	....
1½	53·9339	·9267	·0300	34·68					

Weighted Mean	−32·63
V_a	−11·55
V_d	− ·15
Curvature..	− ·28
Radial velocity...........	− 44·6

α DRACONIS 815

1907. June 10.
G. M. T. 16h 47m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9231	....	....	....	2	54·7184	....	....	....
1½	72·7684	·8054	·0133	−19·34	1½	53·9433	·9471	·0095	10·98
1½	72·3694	....	....	....	1	53·1034	....	....	....
1½	57·7967	....	....	....	2	45·2925	....	....	....
1	57·7938	·7950	·0097	11·73	1½	45 2318	·2236	·0251	−26·35

Weighted mean..........	−17·59
V_a	−11·47
V_d	− ·12
Curvature	− ·28
Radial velocity..	−29·5

α DRACONIS 815*

1907. June 10.
G. M. T. 16h 47m

Observed by J. S. Plaskett.
Measured by N. B. McLean.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9213	....	....	....	½	53·6484	....	....	....
1	72·7622	·8043	·0144	−20·92	1	53·0940	....	....	....
2	72·3575	....	....	....	2	45·2842	....	....	....
2	54·7145	....	....	....	2	45·2268	·2262	·0225	−23·55
1	54·0019	....	....	....	3	44·2704	....	....	....
1½	53·9293	·9423	·0143	−16·50					

Weighted mean....	−20·62
V_a	−11·47
V_d	− ·12
Curvature	− ·28
Radial velocity...........	−32·5

*Check measurement; the mean of the two, 31·0 kms. per sec. was used.

α DRACONIS 823.

1907. June 11.
G. M. T. 14h 17m

Observed by / Measured by } W. E. Harper.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9557	....	....	....	1	54·0131	....	....	....
2	72·7926	·7976	·0211	−30·66	1½	53·9347	·9369	·0197	22·73
1	72·3945	....	....	....	2	45·2836	....	....	....
1½	57·8036	....	....	....	1½	45·2077	·2077	·0410	−42·92
½	57·7961	·7904	·0143	17·24					

Weighted mean.........	−30·62
V_a	−11·43
V_d	− ·12
Curvature..........	− ·28
Radial velocity..........	− 42·4

α DRACONIS 859.

1907. June 20.
G. M. T. 15h 17m

Observed by / Measured by } W. E. Harper.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9723	....	....	....	2	53·9569	·9719	·0021	+2·42
1	72·8087	·8487	·0161	−23·36	1½	53·0967	....	....	....
1½	73·2661	....	....	....	2	45·2665	....	....	....
2	54·7300	....	....	....	1½	45·2236	·2307	·0080	−8·37

Weighted mean........	− 9·05
V_a	−10·87
V_d	− ·12
Curvature...........	− ·28
Radial velocity........	−20·3

α DRACONIS 870.

1907. June 21.
G. M. T. 16h 36m

Observed by J. S. Plaskett.
Measured by N. B. McLean.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
1	73·0191	....	....	....	1	53·9945	·9665	·0033	− 3·80
½	72·8634	·8530	·0118	− 17·12	1	45·3060	....	....	....
1	72·4577	....	....	....	½	45·2782	·2458	·0071	+ 7·41
1	54·0568	....	.. ..	....					

Weighted mean	−	6·37
V_a	−	10·79
V_d	−	·12
Curvature.....	−	·28
Radial Velocity	−	17·6

α DRACONIS 870.

1907. June 21.
G. M. T. 16h 36m

Observed by, Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9975	....	....	....	1½	53·6785	....	....	....
2	72·8430	·8542	·0106	− 15·38	1½	53·1194	....	....	....
3	72·4366	....	....	.. ..	2	45·2851	....	....	....
2	54·7473	.. ..	....	....	3	44·2635	....	....	....
2	54·0370	....	....	....	1	45·2569	·2473	·0086	+ 8·98
3	53·9617	·9533	·0165	− 18·99					

Weighted mean.........	−	13·12
Radial Velocity...	−	24·3

α DRACONIS 911.

1907. July 4.
G. M. T. 15^h 02^m

Observed by } W. E. HARPER.
Measured by }

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	72·9870	....	....	....	2	54·0187	·0297	·0599	68·94
½	72·8801	·9021	·0373	+ 54·13	1½	53·1057	....	....	....
1	72·4322	....	....	....	2	45·2628	....	....	....
2	54·7262	....	....	....	1½	45·2895	·3003	·0616	+ 64·85

Weighted mean ..... +65·55
V_a .... − 9·52
V_d .... − ·12
Curvature .... − ·28

Radial velocity.......................... +55·6

α DRACONIS 916.

1907. July 5.
G. M. T. 14^h 50^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.	Weight.	Mean of Settings.	Corrected Setting.	Displacement in Revns	Velocity.
2	73·0028	....	....	....	1½	53·0129	....	....	....
2	72·8963	9039	·0391	+ 56·74	2	45·2709	....	....	....
1	72·4350	....	....	....	2	45·2857	·2884	·0497	+ 51·87
1½	54·7364	....	....	....	2	27·2771	....	....	....
2	53·0186	·0180	·0482	+ 55·47					

Weighted mean....... +54·69
V_a .... − 9·40
V_d .... − ·09
Curvature .... − ·28

Radial velocity.......................... +44·9

SUMMARY OF VELOCITIES.

Date.	Phase.	Velocity.	Date.	Phase.	Velocity.
1906.			1906.		
July 2·67	0·67	+ 3	Dec. 17·75	14·61	− 7
" 4·75	2·75	+16	" 18·75	15·61	−17
			1907.		
Aug. 15·59	44·59	−32	Jan. 9·67	37·53	−43
" 24·59	2·20	+ 6	" 11·75	39·61	−35
			" 21·67	49·53	− 6
Sept. 10·59	19·20	−30	" 30·71	7·19	+44
" 19·59	28·20	−42			
" 27·54	36·16	−42	Feb. 6·75	14·23	− 4
			" 12·62	20·10	−36
Oct. 3·5	42·12	−39			
" 18·5	5·74	+32	May 22·64	16·57	−18
			" 31·68	25·41	−38
Nov. 1·6	19·76	−40			
" 6·6	24·77	−44	June 8·78	33·50	−45
" 8·6	26·76	−45	" 10·7	35·42	−31
" 16·67	34·91	−50	" 11·6	36·32	−42
" 19·54	37·78	−54	" 20·64	45·36	−20
			" 21·69	46·41	−21
Dec. 7·71	4·57	+31			
" 11·8	8·65	+31	July 4·63	7·96	+56
" 13·54	10·40	+34	" 5·62	8·96	+45

The above table gives us all the available material for the work in hand so far as our own observations are concerned. However, for an accurate determination of the period it is necessary to have observations extending over a long interval, and we were glad to avail ourselves of some early measures of the Yerkes, Lick and Potsdam observatories extending from 1901 to 1906. A summary of all previous observations known to the writer is given in the table below.

PREVIOUS OBSERVATIONS.

Date.	Phase.	Velocity.	Observatory.
1901 Nov. 20·92	11·46	+20	Yerkes.
1902 June 16·6	13·82	+ 1	Lick.
1903 Apr. 29·	22·54	−43	"
" May 4·	27·54	−42	"
" " 23·	46·54	−17	Potsdam.
" " 24·	47·54	− 14	"
1904 June 19·	28·50	−42	Lick.
1905 " 13·	27·84	−42	"
1906 Jan. 4·	27·22	−40	"
" " 5·98	28·47	−42	Yerkes.
" " 8·9	31·43	−55	"
" " 26·89	49·41	− 9	"
" " 29·81	0·95	+ 1	"
" Feb. 9·93	12·07	+24	"

From all the observations, the velocity curve was plotted beginning with an arbitrary epoch, July 2·0 d, 1906. Previous observations were brought forward by a sufficient number of periods and subsequent ones similarly brought back. A period of 51·38 days brought the observations into the best agreement and owing to the number of periods available, about forty, this can not be in error more than one or two hundredths of a day. From this period, the phases given in the tables of velocities above were computed.

Mr. Harper, in his paper on the orbit of α Draconis, published in the Journal R. A. S. C., which is given below as appendix C, gives a complete discussion of the available data and obtains the velocity curve fig. 1, Appendix C, and elements from an analytical method due to Russell.* I obtained independently from the same data the velocity curve fig. 2, Appendix C, and slightly different elements by the method of Lehmann-Filhes.† In both cases a preliminary curve was drawn from which preliminary elements were obtained. An ephemeris was then computed from these elements and the corresponding curves drawn which deviated from the original curves in several places. An indication was thereby given of the general form of the curve and this was used to indicate the changes to be made in drawing the second curve. These changes did not, however, in any case affect the agreement of the curve with the observations, but in some cases improved it. This was possible on account of the comparatively high residuals which allowed considerable latitude in curve drawing.

A second set of elements was computed from these second curves. In the analytical method. Mr. Harper found it necessary to again change these values of e and ω to bring the curve drawn through the computed points into agreement with the observational curve. In the geometrical method, the curve computed from the second set of elements was found to agreë closely with the observations and no further change was deemed necessary.

As the observations are scarcely of sufficient accuracy to permit of applying a least squares method of correction, the method followed above is perhaps as satisfactory as possible, although possibly not carried sufficiently far to give the most accurate values of the elements. As several other geometrical methods of obtaining the elements from the velocity curve have been deduced by Schwarzschild§ and quite recently by Zurhellen‡, it has been deemed of sufficient value and interest to give determinations of the elements of α Draconis by each of these methods. Further, in order to bring together in one place the various methods, and for convenience in our own work, the essential steps of each are summarized below, using, as far as possible, the notations of the original authors. Following each method is given as a numerical example the values of the elements for α Draconis, the velocity curve used being reproduced in fig. 7. This curve is almost identical with fig. 2, Appendix C, of Harper's paper below, but was redrawn from the observation. Very slight differences in the drawing make sometimes considerable variation in some of the elements, and this will explain the slightly different values of e and ω obtained by Lehmann-Filhes method from practically the same curve.

SPECTROSCOPIC BINARY ORBITS.

General Symbols.

a = major semi-axis of the orbit of the bright star around the centre of gravity of the system.

e = eccentricity.

ϕ = eccentricity angle $e = \sin\ \phi$.

ω = angular distance of periastron from the ascending node.

T = time of periastron passage.

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* Astrophysical Journal XV p. 252.

† Astronomische Nachrichten, 3242.

§ Astronomische Nachrichten, No. 3629.

‡ Astronomische Nachrichten, No. 4191.

i = inclination of the plane of the orbit to the normal plane.
U = periodic time.

μ = mean daily motion $= \dfrac{2\pi}{U}$

$\left.\begin{array}{l} v = \text{true} \\ M = \text{mean} \\ E = \text{eccentric} \end{array}\right\}$ anomalies.

u = angular distance of the star from the ascending node $= v + \omega$.
γ = velocity of the centre of gravity of the system with respect to the sun.

$\left.\begin{array}{l} A = \text{maximum velocity in the orbit} \\ B = \text{minimum velocity in the orbit} \end{array}\right\}$ Both taken positive.

N_1 = maximum velocity with respect to the sun.
N_2 = minimum velocity with respect to the sun.

Fundamental Equations.

Take the production of the line of sight through the centre of gravity of the system as the z axis, while the x axis lies along the intersection of the normal plane with the orbit plane, positive towards the ascending node. Then

$$\frac{dz}{dt} = g = \gamma + \frac{f}{\sqrt{p}} \sin i \,(\cos u + e \cos \omega) \qquad (1)$$

If we put $D = \dfrac{f \sin i}{\sqrt{p}}$, $C = \gamma + D\, e \cos \omega$ then

$$\left.\begin{array}{l} \dfrac{dz}{dt} = g = \gamma + D \cos\phi . \dfrac{\cos\phi \cos\omega \cos E - \sin\omega \sin E}{1 - e \cos E} \\ \dfrac{dz}{dt} = g = C + D \cos u \end{array}\right\} \qquad (2)$$

$$\therefore N_1 = C + D.$$
$$N_2 = C - D.$$
$$C = \frac{N_1 + N_2}{2} = \gamma + \frac{A - B}{2}$$
$$D = \frac{N_1 - N_2}{2} = \frac{A + B}{2}$$

*Method of Lehmann-Filhes.**

The velocity curve—abscissa, times, ordinates, velocities—is drawn agreeing as closely as possible with the observed points. Considering $\gamma = 0$

$$\frac{dz}{dt} = \frac{f}{\sqrt{p}} \sin i \,(\cos u + e \cos \omega) \qquad (3)$$

and at maximum and minimum

$$A = \frac{f}{\sqrt{p}} \sin i \,(1 + e \cos \omega)$$
$$B = \frac{f}{\sqrt{p}} \sin i \,(1 - e \cos \omega)$$

$$\left.\begin{array}{l} \dfrac{f}{\sqrt{p}} \sin i = \dfrac{A + B}{2} \\ \dfrac{f}{\sqrt{p}} \sin i \; e \cos \omega = \dfrac{A - B}{2} \\ e \cos \omega = \dfrac{A - B}{A + B} \end{array}\right\} \qquad (4)$$

$$\frac{dz}{dt} = \frac{A + B}{2} \cos u + \frac{A - B}{2} \qquad (5)$$

* Astronomische Nachrichten No. 3242.

In the curve used as an example fig. 7, A corresponds to transit through the ascending, B through the descending node. $\int \frac{dz}{dt} dt$, the area between curve, axis, and two ordinates is proportional to the difference of the z's to which these ordinates correspond.

This extended over a whole period, say from ascending node A to next ascending node A' must vanish, hence the areas above and below the axis must be equal. If this condition is not fulfilled, determined easily by counting the squares of cross section paper, the axis must be raised or lowered until the areas are equalized.

Consider the points C and D fig. 7 in which $\frac{dz}{dt} = 0$ then from (3) or (5)

$$\cos u = -e \cos \omega = -\frac{A-B}{A+B} \tag{6}$$

at the corresponding times t_1, t_2 the star is moving parallel to the nodal line. As it moves as far away from the ascending node as towards the descending node, $\int \frac{dz}{dt} dt$ from ascending to descending and also from descending to ascending nodes must be each zero. Therefore the area AC must equal CB and BD equal DA' and the curve drawing, with the positions of the maximum and minimum points, must be conformed to the above conditions.

At C and D from (6)

$$\sin u_1 = \frac{2\sqrt{AB}}{A+B}, \quad \cos u_1 = -\frac{A-B}{A+B}$$

$$\sin u_2 = -\frac{2\sqrt{AB}}{A+B}, \quad \cos u_2 = -\frac{A-B}{A+B}$$

$$\therefore u_2 = 2\pi - u_1$$

If we represent the maximum values of z by z_1 and z_2 (proportional to areas AC and BD respectively) and the corresponding radii vectors by r_1 and r_2 then

$$z_1 = r_1 \sin i \sin u_1$$

$$z_2 = r_2 \sin i \sin u_2 = -r_2 \sin i \sin u_1$$

$$\frac{r_1}{r_2} = -\frac{z_1}{z_2}$$

$$r_1 = \frac{p}{1 + e \cos (u_1 - \omega)} \quad r_2 = \frac{p}{1 + e \cos (u_1 + \omega)}$$

$$\therefore \frac{z_1}{z_2} = \frac{1 + e \cos u_1 \cos \omega - e \sin u_1 \sin \omega}{1 + e \cos u_1 \cos \omega + e \sin u_1 \sin \omega} \text{ and from (6)}$$

$$\frac{\sin u_1 - e \sin \omega}{\sin u_1 + e \sin \omega} = -\frac{z_1}{z_2}$$

$$e \sin \omega = \frac{z_2 + z_1}{z_2 - z_1} \sin u_1 \tag{7}$$

giving with (6) e and ω.

At periastron T, $u = \omega$ and from (3) and (4)

$$\frac{dz}{dt} = \frac{A+B}{2} (1+e) \cos \omega \tag{8}$$

Also from the known values of u_1 and t_1 of the point C we get

$$\tan \frac{E_1}{2} = \sqrt{\frac{1-e}{1+e}} \cdot \tan \frac{u_1 - \omega}{2}$$

$$T = t_1 - \frac{E_1 - e \sin E_1}{\mu} \tag{9}$$

As the mean daily movement

$$\mu = \frac{2\pi}{U} = \frac{f}{a^{3/2}} \text{ and from (4)}$$

$$\mu = \frac{A+B}{2} \cdot \frac{\sqrt{p}}{\sin i} \cdot \frac{1}{a^{3/2}}$$

$$\therefore a \sin i = \frac{A+B}{2\mu} \sqrt{1-e^2} \text{ and reducing to the same units}$$

$$a \sin i = 43200 \frac{A+B}{\mu} \sqrt{1-e^2} \qquad (10)$$

Example.

In the curve the γ axis is $16 \cdot 93^{\text{kms}}$ below the axis of zero velocity.

t_1 at maximum ordinate $= 8 \cdot 0$ $\quad z_1 = 262 \cdot 5 \quad A = 66 \cdot 18$
t_2 at minimum ordinate $= 28 \cdot 58$ $\quad z_2 = -362 \cdot 5 \quad B = 27 \cdot 52$
$\log e \cos \omega = 9 \cdot 61552$
$\log \sin u_1 = 9 \cdot 95948 \quad \therefore \quad u_1 = 114°$ ′
$\log e \sin \omega = 9 \cdot 16360$
$e = 0 \cdot 438 \qquad \omega = 19° \ 27'$
$T =$ ordinate $46 \cdot 85 \ (1 \cdot 438) \cos 19° \ 27' = 62 \cdot 06 \quad \therefore \quad T = 9 \cdot 1$

Also $\log \tan \frac{E_1}{2} = 9 \cdot 83350 \quad E_1 = 1 \cdot 19642$

$E_1 - e \sin E_1 = \cdot 78915 \quad \mu = \cdot 12229$
$\therefore \ T = 15 \cdot 6 - 6 \cdot 45 = 9 \cdot 15 =$ July $11 \cdot 15$
$a \sin i = 29{,}763{,}000$ km.

*Method of Schwarzschild.**

Draw in the position C or midway between the maximum and minimum points of the curve a parallel to the axis of abscissa calling the new ordinates ζ. Then

$$\frac{dz}{dt} - C = \zeta = D \cos u$$

It is required to find pairs of points on the curve distant $\frac{U}{2}$ from one another whose ordinates ζ are equal but of opposite sign. If the curve with the ζ axis be traced, be placed on the original after turning it through 180° around the ζ axis, and be moved along this axis the distance $\frac{U}{2}$, the intersections of the two curves will be points fulfilling these conditions. There will in general be four intersecting points P_1, P_2, P_3, P_4, two pairs, the two points of a pair being easily recognized as their ordinates are $\frac{U}{2}$ apart.

The abscissa of the points are t_1, $t_2, = t_1 + \frac{U}{2}$, t_3, $t_4 = t_3 + \frac{U}{2}$ and their ordinates ζ_1, $\zeta_2 = -\zeta_1$, ζ_3, $\zeta_4 = -\zeta_3$

$$\frac{\zeta_1}{D} = \cos u_1 \qquad \frac{\zeta_2}{D} = \cos u_2 = -\cos u_1$$

$$\therefore u_2 = u_1 + \pi \ (a) \text{ or } u_1 + u_2 = \pi \ (b)$$

(a) is fulfilled if the points of the pair lie on different branches (b) if they lie on the same branch of the curve. If P_1 and P_2 are on different branches then

$$u_1 = v_1 + \omega \qquad u_2 = v_2 + \omega \qquad \therefore \ v_2 = v_1 + \pi$$

Hence P_1 and P_2 must be the positions of periastron and apastron and the former is

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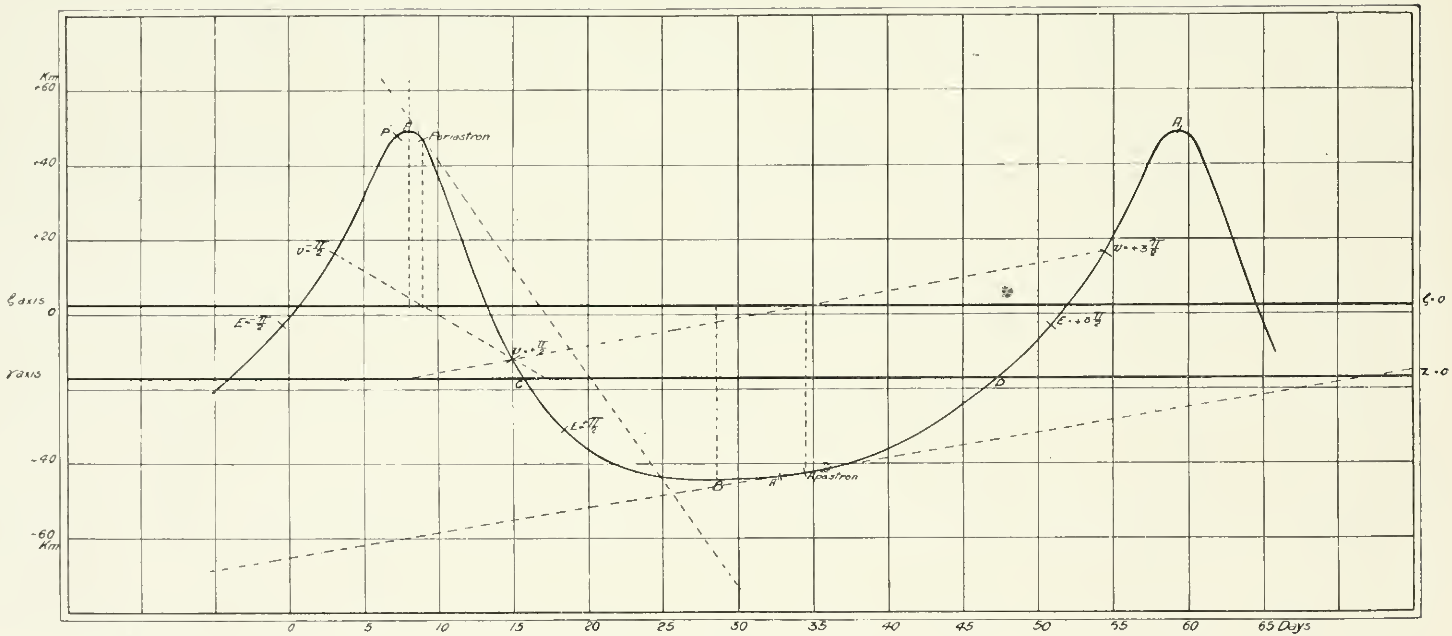

FIG. 7.—Velocity Curve of α Draconis.

easily distinguished by two conditions. 1. Around periastron the curve is more steeply inclined to the axis of abscissa. 2. The curve extends over a shorter time interval on the side of the ζ axis on which periastron lies.

As in periastron $v = o \quad u = \omega$ so we obtain from the ordinate of the periastron ζ its longitude ω

$$\frac{\zeta}{D} = \cos \omega \tag{11}$$

Choose any point Q with abscissa t and ordinate ζ nearly midway between periastron and apastron. Find point Q' with abscissa t' whose ordinate $\zeta' = -\zeta$. There are generally two such points, one on the same, one on the other branch of the curve. Choose the point on the other branch then

$$\frac{\zeta}{D} = \cos u \qquad \frac{\zeta'}{D} = \cos u' = -\cos u$$

$$u' = u + \pi \quad \text{also}$$

$$u = v + \omega, \qquad u' = v' + \omega, \qquad v' = v + \pi \tag{12}$$

Let the corresponding eccentric anomalies be E and E'

$$E - e \sin E = 2\,\pi \frac{t - T}{U}$$

$$E' - e \sin E' = 2\,\pi \frac{t' - T}{U}$$

$$E' - E - e\,(\sin E' - \sin E) = 2\,\pi \frac{t' - t}{U} \tag{13}$$

$$\tan \frac{v}{2} = \tan \frac{E}{2} \sqrt{\frac{1+e}{1-e}}, \quad \tan \frac{v'}{2} = \tan \frac{E'}{2} \sqrt{\frac{1+e}{1-e}} \tag{14}$$

$$\tan \frac{v}{2} \tan \frac{v'}{2} = -1$$

$$\therefore \tan \frac{E}{2} \tan \frac{E'}{2} = \frac{e-1}{e+1}$$

$$e = \frac{\cos \frac{E'-E}{2}}{\cos \frac{E'+E}{2}} \tag{15}$$

$$e\,(\sin E' - \sin E) = \sin\,(E' - E)$$

$$E' - E - \sin\,(E' - E) = 2\,\pi \frac{t' - t}{U} \tag{16}$$

From (14) and (12) we get

$$\sin \frac{E'+E}{2} = \cos v \sin \frac{E'-E}{2} \tag{17}$$

If we place $\frac{E'-E}{2} = \eta \qquad \frac{E'+E}{2} = \xi$ equation (16) becomes

$$2\,\eta - \sin 2\,\pi = 2\,\pi \frac{t' - t}{U} \tag{18}$$

The solution of this equation is given in the table below which gives the value of η corresponding to any value of $\frac{t' - t}{U}$, which is in turn obtained from the abscissa t and t' of the points Q and Q'.

From the ordinate ζ of Q we have

$$\frac{\zeta}{D} = \cos u \qquad v = u - \omega$$

$$\sin \xi = \cos v \sin \eta$$

$$e = \frac{\cos \eta}{\cos \xi} \tag{19}$$

$$a \sin i = D \frac{U}{2\pi} \sqrt{1-e^2} \tag{20}$$

$$\frac{m^3 \sin^3 i}{(m+m')^2} = \frac{U}{2\pi k^2} D^3 (\sqrt{1-e^2})^3 \tag{21}$$

$$\gamma = C - D\, e \cos \omega \tag{22}$$

If the relative velocity of one star against the other has been observed $\gamma = o$ and therefore

$$\frac{C}{D} = e \cos \omega \tag{23}$$

giving e when ω has been determined.

SOLUTION OF THE EQUATION $2\eta - \sin 2\eta = 2\pi \frac{t'-t}{U}$

η	$\frac{t'-t}{U}$	η	$\frac{t'-t}{U}$	η	$\frac{t'-t}{U}$	η	$\frac{t'-t}{U}$	η	$\frac{t'-t}{U}$	η	$\frac{t'-t}{U}$
°		°		°		°		°		°	
0	0·0000	30	0·0290	60	0·1956	90	0·5000	120	0·8044	150	0·9710
1	0·0000	31	0·0318	61	0·2040	91	0·5111	121	0·8127	151	0·9738
2	0·0000	32	0·0348	62	0·2125	92	0·5222	122	0·8208	152	0·9763
3	0·0000	33	0·0386	63	0·2213	93	0·5333	123	0·8287	153	0·9787
4	0·0001	34	0·0414	64	0·2303	94	0·5443	124	0·8364	154	0·9809
5	0·0001	35	0·0450	65	0·2393	95	0·5554	125	0·8439	155	0·9830
6	0·0002	36	0·0488	66	0·2485	96	0·5665	126	0·8512	156	0·9849
7	0·0004	37	0·0527	67	0·2578	97	0·5774	127	0·8584	157	0·9867
8	0·0006	38	0·0568	68	0·2673	98	0·5883	128	0·8654	158	0·9883
9	0·0008	39	0·0611	69	0·2769	99	0·5992	129	0·8722	159	0·9897
10	0·0011	40	0·0656	70	0·2867	100	0·6100	130	0·8788	160	0·9911
11	0·0015	41	0·0703	71	0·2966	101	0·6207	131	0·8853	161	0·9923
12	0·0020	42	0·0751	72	0·3065	102	0·6313	132	0·8915	162	0·9935
13	0·0025	43	0·0802	73	0·3166	103	0·6419	133	0·8975	163	0·9945
14	0·0031	44	0·0855	74	0·3268	104	0·6525	134	0·9033	164	0·9954
15	0·0038	45	0·0910	75	0·3371	105	0·6629	135	0·9090	165	0·9962
16	0·0046	46	0·0967	76	0·3475	106	0·6732	136	0·9145	166	0·9969
17	0·0055	47	0·1025	77	0·3581	107	0·6834	137	0·9198	167	0·9975
18	0·0065	48	0·1085	78	0·3687	108	0·6935	138	0·9249	168	0·9980
19	0·0077	49	0·1147	79	0·3793	109	0·7034	139	0·9297	169	0·9985
20	0·0089	50	0·1212	80	0·3900	110	0·7133	140	0·9344	170	0·9989
21	0·0103	51	0·1278	81	0·4008	111	0·7231	141	0·9389	171	0·9992
22	0·0117	52	0·1346	82	0·4117	112	0·7327	142	0·9432	172	0·9994
23	0·0133	53	0·1416	83	0·4226	113	0·7422	143	0·9473	173	0·9996
24	0·0151	54	0·1488	84	0·4335	114	0·7515	144	0·9512	174	0·9998
25	0·0170	55	0·1561	85	0·4446	115	0·7607	145	0·9550	175	0·9999
26	0·0191	56	0·1636	86	0·4557	116	0·7697	146	0·9586	176	0·9999
27	0·0213	57	0·1713	87	0·4667	117	0·7787	147	0·9620	177	1·0000
28	0·0237	58	0·1792	88	0·4778	118	0·7875	148	0·9652	178	1·0000
29	0·0262	59	0·1873	89	0·4889	119	0·7960	149	0·9682	179	1·0000

Example of Schwarzschild's Method.

T of periastron $= 8 \cdot 95 \qquad = \text{July } 10 \cdot 95.$

apastron $= 34 \cdot 52$

$\zeta_1 = 44 \cdot 4, \qquad \zeta_2 = -45 \cdot 0, \qquad D = 46 \cdot 85$

$$\cos \omega = \frac{44 \cdot 4}{46 \cdot 85}, \qquad \underline{\underline{\omega = 18^\circ \ 37'}}$$

Take $t = 20 \qquad \zeta = -38 \cdot 7$

$t' = \ 6 \cdot 08 \quad \zeta' = +38 \cdot 7$

$$\frac{t' - t}{U} = \frac{13 \cdot 92}{51 \cdot 38} = \cdot 2709 \qquad \eta = \underline{\underline{69^\circ \cdot 375}}$$

$$\cos u = \frac{-38 \cdot 7}{46 \cdot 85} \qquad u = 145^\circ \cdot 69$$

$v = 127^\circ \cdot 07$

$\log \sin \xi = 9 \cdot 75140, \quad \log \cos \xi = 9 \cdot 91680, \quad \log \cos \eta = 9 \cdot 54685$

$\log e = 9 \cdot 63005 \qquad \underline{\underline{e = 0 \cdot 427}}$

$\log a \sin i = \log 86400 + \cdot 91261 + \bar{1} \cdot 95637 + 1 \cdot 67071$

$a \sin i = 29{,}936{,}000^{\text{kms.}}$

$\gamma = 2 \cdot 4 - [1 \cdot 67071 + 9 \cdot 63005 + 9 \cdot 97665]$

$= \underline{\underline{-16 \cdot 55^{\text{kms.}}}}$

*Methods of Zurhellen.**

The integral conditions of Lehmann-Filhes are more simply determined as follows:—

Copy the curve with axis of abscissa on tracing paper, turn the copy in its plane 180° and move it along on the γ axis until the ordinates of a maximum and a minimum fall on one another. Then Lehmann-Filhes conditions are equivalent to saying that the areas between these ordinates, the γ axis, and the quadrants of the curve must be equal. This method works well when e is small, but if e is large the dissimilarity of the portions above and below the γ axis prevents its being advantageously used.

In Zurhellen's methods for determining e and ω

g denotes observed velocity.

ζ denotes velocity with respect to mean axis.

z denotes velocity with respect to γ axis or the velocity in the orbit.

$$\therefore \ g - \gamma = z = \zeta + D \, e \cos \omega \tag{24}$$

Zurhellen's First Method.

This differs only from Schwarzschild's by using the difference of the ordinates of periastron and apastron for the determination of ω

$$\cos \omega = \frac{\zeta_P - \zeta_A}{2 \ D} \tag{25}$$

Example.

$\zeta_P = 44 \cdot 4 \qquad \zeta_A = -45 \cdot 0 \qquad D = 46 \cdot 85$

$$\cos \omega = \frac{89 \cdot 4}{93 \cdot 7} \qquad \omega = 17^\circ \ 25'$$

and using changed value of ω as in Schwarzschild's example $\quad e = 0 \cdot 432.$

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Zurhellen's Second Method.

Instead of choosing the points Q and Q', as in Schwarzschild's method, about midway between periastron and apastron, choose them where $v = \mp \frac{\pi}{2}$, or at the ends of the parameter

$$v = -\frac{\pi}{2} \qquad g_1 - \gamma = D \left\{ \cos\left(\omega - \frac{\pi}{2}\right) + e \cos\omega \right\}$$
$$= D\ (\sin\omega + e\cos\omega)$$
$$v = +\frac{\pi}{2} \qquad g_2 - \gamma = D \left\{ \cos\left(\omega + \frac{\pi}{2}\right) + e \cos\omega \right\}$$
$$= D\ (-\sin\omega + e\cos\omega)$$

Therefore from (24)

$$\zeta_1 = +D \sin\omega \qquad E_1 = -E_2$$
$$\zeta_2 = -D \sin\omega \qquad M_1 = -M_2$$
$$t_1 - T = -(t_2 - T)$$

The points lie therefore in ζ symmetrical to the ζ axis and in t symmetrical to the periastron.

Lay the tracing on the curve, rotate it in its own plane 180° around the intersection of the periastron ordinate with the ζ axis. It intersects the original curve in two points, which are those required and which must be on different branches of the curve. Now as

$$\tan\frac{E}{2} = \tan\frac{v}{2}\tan\left(\frac{\frac{\pi}{2} - \phi}{2}\right) \text{ and for } \tan\frac{v}{2} = \mp 1$$

$$E_1 = -\left(\frac{\pi}{2} - \phi\right),\quad E_2 = +\left(\frac{\pi}{2} - \phi\right)$$

$$M_1 = -\left(\frac{\pi}{2} - \phi\right) + \sin\phi \sin\left(\frac{\pi}{2} - \phi\right)$$

$$M_2 = +\left(\frac{\pi}{2} - \phi\right) - \sin\phi \sin\left(\frac{\pi}{2} - \phi\right)$$

$$\therefore \frac{2\pi}{U}(t_2 - t_1) = M_2 - M_1 = \pi - 2\phi - \sin(\pi - 2\phi) \qquad \textbf{(26)}$$

$t_2 - t_1$ can be directly read off and then $\frac{\pi}{2} - \phi$ can be taken from Schwarzschild's table above.

The ordinates of the points $v = \mp \frac{\pi}{2}$ give ω

$$\sin\omega = \frac{\zeta_1 - \zeta_2}{2D} \text{ or } \tan\omega = \frac{\zeta_1 - \zeta_2}{\zeta_P - \zeta_A} \qquad \textbf{(27)}$$

As a control the lines joining the points $v = -\frac{\pi}{2}$ and $v = +\frac{\pi}{2}$ and also $v = +\frac{\pi}{2}$ and $v = +\frac{3\pi}{2}$ must intersect the ζ axis in the abscissa of periastron and apastron.

Example.

For $v = +\dfrac{\pi}{2}$ $\qquad \zeta_1 = \quad 14\cdot0 \qquad t_1 = \ 2\cdot95$

$v = -\dfrac{\pi}{2} \qquad \zeta_2 = -14\cdot4 \qquad t_2 = 15\cdot0$

$\dfrac{t_2 - t_1}{U} = \dfrac{12\cdot05}{51\cdot38} = \cdot2345 \qquad \therefore \dfrac{\pi}{2} - \phi = 64^\circ\cdot47$

$\phi = 25^\circ\cdot53 \qquad e = \underline{\underline{0\cdot431}}$

$\sin\omega = \dfrac{14\cdot0+14\cdot4}{93\cdot7} = \dfrac{28\cdot4}{93\cdot7} \qquad \tan\omega = \dfrac{28\cdot4}{89\cdot4}$

$\omega = \underline{\underline{17^\circ \ 39'}}$ or $\underline{\underline{17^\circ \ 37'}}$

The values of e and ω obtained by these two methods are reliable as ω is small and the ζ's accurately known.

Zurhellen's Third Method.

Frequently the direction of the curve at periastron and apastron is sharply defined and is changed the less by a movement of these points the nearer they are to the null points (velocity in orbit 0).

$$\frac{dg}{dt} = \frac{2\pi}{U}\frac{dg}{dM} = \frac{2\pi}{U} \cdot \frac{1}{1 - e\cos E} \cdot \frac{dg}{dE}$$

$$= \frac{2\pi}{U} \cdot D\cos\phi \cdot \frac{-\cos\phi\cos\omega\sin E - \sin\omega\cos E + e\sin\omega}{(1-e\cos E)^3}$$

At periastron $E = o$, and at apastron $E = \pi$

$$\left.\begin{aligned}\left(\frac{dg}{dt}\right)_P &= -\frac{2\pi}{U} \cdot D\cos\phi \cdot \frac{\sin\omega}{(1-e)^2}\\ \left(\frac{dg}{dt}\right)_A &= +\frac{2\pi}{U} \cdot D\cos\phi \cdot \frac{\sin\omega}{(1+e)^2}\end{aligned}\right\} \qquad (28)$$

$$\left(\frac{dg}{dt}\right)_P : \left(\frac{dg}{dt}\right)_A = -\left(\frac{1+e}{1-e}\right)^2$$

If we take this ratio $= -k^2$ and take k positive

$$e = +\frac{k-1}{k+1} \qquad (29)$$

Calling $\left(\dfrac{dg}{dt}\right)_P$, p and $\left(\dfrac{dg}{dt}\right)_A$, a

$$p \cdot a = -4\pi^2\left(\frac{D}{U}\right)^2\frac{\sin^2\omega}{\cos^2\phi}$$

$$\sin\omega = \frac{U}{2\pi D}\cos\phi\sqrt{-p \cdot a} \qquad (30)$$

Example.

$\left(\dfrac{dg}{dt}\right)_P$ or $p = -\dfrac{75\cdot0}{52\cdot35} = [\cdot15714]_n \qquad \dfrac{U}{D} = \dfrac{102\cdot76}{23\cdot425} = [\cdot64214]$

$\left(\dfrac{dg}{dt}\right)_A$ or $a = \dfrac{24\cdot3}{144\cdot5} = [9\cdot22634]$

$p : a = [\cdot93080]_n$

$\log k = \cdot46540 \qquad k = 2\cdot920$

$e = \dfrac{1\cdot920}{3\cdot920} = \underline{\underline{\mathbf{0\cdot490}}}$

$\log p \,.\, a = 9{\cdot}38348 \qquad \log \dfrac{U}{2\,\pi\, D} = 9{\cdot}84396$

$\sin \phi = 0{\cdot}490 \qquad \log \cos \phi = 9{\cdot}94042$

$\log \sin \omega = 9{\cdot}47612 \qquad \omega = 17° \;\; 25'$

As, owing to the position of periastron near the peak of the curve, the direction of the tangent is not accurately known, the values for e and ω obtained in this method will not be very reliable.

Zurhellen's Fourth Method.

The γ axis is henceforward taken as the axis of abscissa and the ordinates designated by Z.

According to Schwarzschild.

$$\left.\begin{aligned} e &= \frac{Z\ (\max) + Z\ (\min)}{Z_P - Z_A} \\ \omega &= \frac{Z_P - Z_A}{2\ D} \end{aligned}\right\} \qquad (31)$$

Example.

$$e = \frac{66{\cdot}18 - 27{\cdot}52}{44{\cdot}4 + 45{\cdot}0} = \underline{\underline{0{\cdot}432}}$$

$$\cos \omega = \frac{89{\cdot}4}{93{\cdot}7} \qquad \omega = \underline{\underline{17° \;\; 25'}}$$

Zurhellen's Fifth Method.

In this method the null points $g = \gamma$ are used. If we represent all these magnitudes with the upper index o and distinguish by the subscripts 1 and 2 the formula (2) gives when $g = \gamma$.

$$\tan E^0 = \cot \omega \ \cos \phi,\ E_2^0 = E_1^0 + \pi \qquad (32)$$

$$M_2^0 + M_1^0 = E_2^0 + E_1^0 - e\ (\sin E_2^0 + \sin E_1^0) = E_2^0 + E_1^0$$

$$M_2^0 - M_1^0 = E_2^0 - E_1^0 - e\ (\sin E_2^0 - \sin E_1^0) = \pi - 2\ e\ \cos \frac{M_2^0 + M_1^0}{2}$$

$$\therefore\ e = \pi \left\{ \frac{1}{2} \ \frac{t_2^0 - t_1^0}{U} \right\} \sec \frac{2\,\pi}{U} \left\{ \frac{t_2^0 + t_1^0}{2} - T \right\} \qquad (33)$$

$$\tan \omega = -\cos \phi \ \tan \frac{2\,\pi}{U} \left\{ \frac{t_2^0 + t_1^0}{2} - T \right\} \qquad (34)$$

$$\left.\begin{aligned} E_1^0 &= \tfrac{1}{2}\ (M_1^0 + M_2^0) - + \frac{\pi}{2} \\ E_1^0 &= \tfrac{1}{2}\ (M_1^0 + M_2^0) + - \frac{\pi}{2} \end{aligned}\right\} \qquad (35)$$

Example.

$t_1^0 = 15{\cdot}74 \qquad \dfrac{1}{2}\ \dfrac{t_2^0 - t_1^0}{U} = -\dfrac{5{\cdot}85}{51{\cdot}38}$

$t_2^0 = 47{\cdot}28$

$T = 8{\cdot}95 \qquad \dfrac{t_1^0 + t_2^0}{2} - T = 22{\cdot}56$

$$\log \pi \left(\frac{1}{2} \ \frac{t_2^0 - t_1^0}{U} \right) = n\ 9{\cdot}55352$$

$$\frac{2\,\pi}{U} \left(\frac{t_1^0 + t_2^0}{2} - T \right) = 158°{\cdot}17$$

$\log \sec 158^\circ\cdot 17 = n\ 0\cdot 03232$, $\log \tan 158^\circ\cdot 17 = 9\cdot 60269$

$\log e = n\ 0\cdot 03232 + n\ 9\cdot 55352 = 9\cdot 58584$

$e = \underline{\underline{0\cdot 358}}$

$\log \cos \phi = 9\cdot 96510$

$\log \tan \omega = 9\cdot 96510 + 9\cdot 60269 = 9\cdot 56779$

$\omega = \underline{\underline{20^\circ \quad 17'}}$

This method like Lehmann-Filhes alternative method of obtaining e fails to give accordant results and is not in general very reliable.

Zurhellen's Sixth Method.

If the second and the fifth methods have been used, we get a further value of e without difficulty.

If we join the points $v = \mp \frac{\pi}{2}$ and $v = + \frac{\pi}{2}$ and $v = + \frac{3\pi}{2}$ the lines cut a length d from the γ axis of the following property.

$$d : U = (\sin \omega - e \cos \omega) : 2 \sin \omega = \tfrac{1}{2} - \tfrac{1}{2}\, e \cot \omega$$
$$= \tfrac{1}{2} - \tfrac{1}{2}\ (\cot \omega \cos \phi) \tan \phi$$

and from (32) and (35)

$$\tan \omega \sec \phi = - \tan \frac{M_1^\circ + M_2^\circ}{2}$$

$$\tan \phi = \frac{2\,d - U}{U} \cdot \tan \frac{M_1^\circ + M_2^\circ}{2} \qquad (36)$$

Example.

$$d = 17\cdot 2 - 8\cdot 0 = 9\cdot 2$$

$$\tan \phi = \frac{18\cdot 4 - 51\cdot 38}{51\cdot 38} \tan 158^\circ\cdot 17$$

$\log \tan \phi = n\ 9\cdot 80746 + n\ 9\cdot 60269 = 9\cdot 41015$

$\phi = 14\cdot 42^\circ \qquad e = \underline{\underline{0\cdot 249}}$

$\log \tan \omega = 9\cdot 98610 + 9\cdot 60269 = 9\cdot 58879$

$\omega = \underline{\underline{21^\circ \quad 12'}}$

This is unreliable both on account of the acute intersection of the joining lines and also on account of the unreliability of the fifth method on which it depends.

Zurhellen's Seventh Method.

In the points $E = \mp \frac{\pi}{2}$

$$M_1 = - \frac{\pi}{2} + e$$

$$M_2 = + \frac{\pi}{2} - e$$

$$M_2 - M_1 = \pi - 2e$$

$$e = \pi \left\{ \frac{1}{2} \quad \frac{t_2 - t_1}{U} \right\} \qquad (37)$$

For finding the above points the condition required is that the Z's are of equal magnitude but opposite sign. For from (2)

$Z_1 = + D \cos \phi \sin \omega$

$Z_2 = - D \cos \phi \sin \omega$

The tracing is therefore turned 180° around the intersection of the ordinate of periastron with the γ axis. And we also have

$$\tan \omega = \frac{Z_1 - Z_2}{Z_P - Z_A} \sec \phi \tag{38}$$

A control is given if the points $E = \mp \frac{\pi}{2}$ and $E = + \frac{\pi}{2}$ and $E = + \frac{3\pi}{2}$ are joined. The γ axis must be cut at the abscissa of periastron and apastron. From the ζ axis a length d' of the following properties will be cut out.

$$d' : U = (\sin \omega \cos \phi + e \cos \omega) : -2 \sin \omega \cos \phi$$
$$= \tfrac{1}{2} + \tfrac{1}{2}\, e \cot \omega \sec \phi$$
$$e = \frac{2\, d' - U}{U} \tan \omega \cos \phi = \frac{2\, d' - U}{U} \, \frac{Z_1 - Z_2}{Z_P - Z_A} \tag{39}$$

Example.

$t_1 = -0{\cdot}50 \qquad t_2 = 18{\cdot}40$
$Z_1 = 14{\cdot}3 \qquad Z_2 = -13{\cdot}77$
$Z_P = 61{\cdot}33 \qquad Z_A = -28{\cdot}07$
$\log e = {\cdot}49715 + {\cdot}83187 - 1{\cdot}71079 = 9{\cdot}61823$
$e = \underline{0{\cdot}415}$

$$\log \sec \phi = 0{\cdot}04108 \frac{Z_1 - Z_2}{Z_P - Z_A} = \frac{28{\cdot}07}{89{\cdot}4} = [9{\cdot}49690]$$
$\omega = \underline{19° \quad 2'}$

Control.

$d' = 61{\cdot}25$

$$e = \frac{122{\cdot}5 - 51{\cdot}38}{51{\cdot}38} \cdot \frac{28{\cdot}07}{89{\cdot}4} = \underline{0{\cdot}434}$$

These methods, though giving fairly accordant results in this case, can not in general be considered so trustworthy as the earlier methods.

Zurhellen's Eighth Method.

In many cases the abscissae of the extreme values are accurately known. The condition equations for these, which are designated by the upper index m, are as follows:—

$$\tan v^m = -\tan \omega$$
$$\frac{\sin E^m}{\cos E^m - e} = -\tan \omega \sec \phi$$
$$\sin E_1^m (\cos E_2^m - e) = \sin E_2^m (\cos E_1^m - e)$$
$$\sin (E_2^m - E_1^m) = e \sin E_2^m - e \sin E_1^m = E_2^m - M_2^m - E_1^m + M_1^m$$
$$E_2^m - E_1^m - \sin (E_2^m - E_1^m) = M_2^m - M_1^m$$

and as $M_2^m - M_1^m = 2\pi \frac{t_2^m - t_1^m}{U}$ we get

$\frac{1}{2} (E_2^m - E_1^m)$ from Schwarzschild's table.

From (32)

$$\tan \omega \sec \phi = + \cot E^o$$
$$\cos (E^m - E_o) = + e \cos E^o$$

An equation that holds for each combination of one extreme with one null point. If we consider everything with respect to one determined null point say 1 then.

$$E_1^m - E_1^o = -(E_2^m - E_1^o) \quad \text{and by (35)}$$

$$\tfrac{1}{2}\ (E_1^m + E_2^m) = E_1^o = \tfrac{1}{2}\ (M_1^o + M_2^o) - \frac{\pi}{2}$$

$$\cos\ (E_1^m - E_1^o) + \cos\ (E_2^m - E_1^o) = +2\, e \cos E_1^o$$

$$e = \cos\ \tfrac{1}{2}\ (E_2^m - E_1^m)\ \sec\ E_1^o$$

$$= \cos\ \tfrac{1}{2}\ (E_2^m - E_1^m)\ \operatorname{cosec}\ \tfrac{1}{2}\ (M_1^o + M_2^o) \tag{40}$$

$$\left.\begin{array}{l} \tan\ \omega = -\tan\ v^m \qquad \therefore\ \omega = -v^m \text{ or } \pi - v^m \\ \tan\ \tfrac{1}{2}\ v^m = \tan\left(\dfrac{\pi}{4} + \dfrac{\phi}{2}\right) \tan\ \tfrac{1}{2}\ E^m \end{array}\right\} \tag{41}$$

Example.

$$t_1 = 8{\cdot}0 \qquad t_2 = 28{\cdot}53 \qquad \frac{t_2 - t_1}{U} = {\cdot}3996$$

$$\tfrac{1}{2}\ (E_2^m - E_1^m) = 80^\circ{\cdot}84$$

$$e = \cos\ 80^\circ{\cdot}84\ \ \operatorname{cosec}\ 158^\circ{\cdot}17 = \underline{\underline{0{\cdot}428}} \qquad \phi = 25^\circ{\cdot}35$$

$$E_1^m = 158^\circ{\cdot}17 - 90^\circ - 80^\circ{\cdot}84 = -12^\circ{\cdot}67$$

$$\tan\ \tfrac{1}{2}\ v^m = \tan\ 57^\circ{\cdot}68 \quad \tan - 6{\cdot}33^\circ$$

$$\tfrac{1}{2}\ v^m = -9^\circ{\cdot}953 \qquad v^m = -19^\circ{\cdot}906$$

$$\omega = \underline{\underline{19^\circ \quad 54'}}$$

As this depends upon the abscissa of the maximum and minimum velocities, and as the positive maximum is well defined, and the negative maximum also well known from the equalization of areas, these values are reliable.

Russell's Analytical Method.

In this method the observed radial velocity is developed into a trigonometric series, and the elements are found by comparing this series with the corresponding analytical expression for the velocity.

The theory of the method may be presented as follows: The period U, and the corresponding value μ of the 'mean motion,' are given at once by the observed velocity-curve. The radial velocity, being a known periodic function of the time, may be expanded into a Fourier series of the form

$$\begin{aligned} V = c_0 + c_1\ \cos\ \mu\ (t - t_0) + c_2\ \cos\ 2\ \mu\ (t - t_0) + + \ldots \\ + s_1\ \sin\ \mu\ (t - t_0) + s_2\ \sin\ 2\ \mu\ (t - t_0) + + \ldots \end{aligned} \tag{1}$$

where t represents the time, and t_0 the initial epoch.

The coefficients of this series may best be obtained as follows: Divide the period into any even number 2n of equal parts, beginning at the epoch t_0. Let $v_0, v_1 \ldots \ldots v_{2n-1}$ be the corresponding values of the velocity (v_0 corresponding to t_0).

Then we can get

$$c_0 = \frac{1}{2n}\left[v_0 + v_1 + v_2 + \ldots\ldots\ldots + v_{2n-1}\right]$$

$$c_1 = \frac{1}{n}\left[v_0 + v_1\ \cos\frac{\pi}{n} + v_2\ \cos\frac{2\pi}{n} + + \ldots\ldots\ldots + v_{2n-1}\ \cos\ (2n-1)\frac{\pi}{n}\right]$$

$$c_2 = \frac{1}{n}\left[v_0 + v_1\ \cos\frac{2\pi}{n} + v_2\ \cos\frac{4\pi}{n} + + \ldots\ldots\ldots + v_{2n-1}\ \cos\ (2n-1)\frac{2\pi}{n}\right]$$

$$s_1 = \frac{1}{n}\left[v_1\ \sin\frac{\pi}{n} + v_2\ \sin\frac{2\pi}{n} + + \ldots\ldots\ldots + v_{2n-1}\ \sin\ (2n-1)\frac{\pi}{n}\right]$$

$$s_2 = \frac{1}{n}\left[v_1\ \sin\frac{2\pi}{n} + v_2\ \sin\frac{4\pi}{n} + + \ldots\ldots\ldots + v_{2n-1}\ \sin\ (2n-1)\frac{2\pi}{n}\right]$$

and similar expressions for the remaining coefficients.

The number of parts into which the period should be divided, in order to obtain sufficiently accurate values of the coefficients, depends upon the rate of convergence of the series (1), which in turn, depends upon the eccentricity of the orbit. If this is not more than 0·3 a division into twelve or sixteen parts will suffice. For values of e greater than 0·3 the method is not as suitable as some of the geometrical methods.

Series (1) may now be transformed into the form

$$V = a_0 + a_1 \cos\,[\mu\,(t - t_0) + \alpha_1] + a_2 \cos\,[2\,\mu\,(t - t_0) + \alpha_2] + + \ldots \tag{2}$$

by setting

$$\begin{aligned} a_1 \cos \alpha_1 &= c_1 & \qquad a_2 \cos \alpha_2 &= c_2 \\ a_1 \sin \alpha_1 &= -s_1 & \qquad a_2 \sin \alpha_2 &= -s_2 \end{aligned} \tag{3}$$

We have now to find an analytical expression of the form (2), for the velocity, in terms of the elements. Let

ω = longitude of periastron measured from the descending node.
z = projection of radius vector (r) on line of sight.
V = velocity of the bright star

the other symbols used having their usual significance.

Then we must have

$$V = \gamma + \frac{dz}{dt} \ldots\ldots\ldots\ldots \tag{4}$$

Now,

$$\begin{aligned} z &= r \sin\,(v + \omega)\,.\sin i \\ &= r \cos v\,.\sin i\,.\sin \omega + r \sin v \sin i \cos \omega \end{aligned}$$

$$\therefore \frac{dz}{dt} = \sin i \sin \omega \frac{d}{dt}(r \cos v) + \sin i \cos \omega\,.\frac{d}{dt}(r \sin v) \ldots\ldots \tag{5}$$

For central orbits we have the equations

$$E = M + e \sin E \ldots\ldots\ldots \tag{6}$$

$$r = a\,(1 - e \cos E) \ldots\ldots\ldots \tag{7}$$

$$\cos v = \frac{\cos E - e}{1 - e \cos E} \ldots\ldots\ldots \tag{8}$$

Hence $r \cos v = a\,(\cos E - e)$

$$r \sin v = a\,\sqrt{1 - e^2}\,.\sin E$$

Using equation (6) to develop cos E and sin E in terms of e and M by an application of Lagrange's Theorem we get the following expansions.

$$\begin{aligned} r \cos v = -\tfrac{3}{2}\,a\,e + a\,&(1 - \tfrac{3}{8} e^2 + \tfrac{5}{192} e^4 + \tfrac{7}{9216} e^6 \ldots\ldots) \cos M \\ &+ \tfrac{1}{2}\,a\,e\,(1 - \tfrac{2}{3} e^2 + \tfrac{1}{8} e^4 + \tfrac{1}{90} e^6 \ldots\ldots) \cos 2\,M. \\ &+ \ldots\ldots\ldots \end{aligned}$$

$$\begin{aligned} r \sin v = a\,&(1 - \tfrac{5}{8} e^2 - \tfrac{11}{192} e^4 + \tfrac{119}{9216} e^6 \ldots\ldots\ldots) \sin M \\ &+ \tfrac{1}{2}\,a\,e\,(1 - \tfrac{5}{6} e^2 + \tfrac{1}{12} e^4 + \tfrac{77}{720} e^6 \ldots\ldots) \sin 2\,M \\ &+ \ldots\ldots\ldots \end{aligned}$$

Differentiating, remembering that $\frac{dM}{dt} = \mu$, substituting in (5), and, for brevity, setting

$$\begin{aligned} 1 - \tfrac{3}{8} e^2 + \ldots\ldots &= X_1 \\ 1 - \tfrac{5}{8} e^2 - \ldots\ldots &= Y_1 \\ 1 - \tfrac{2}{3} e^2 + \ldots\ldots &= X_2 \\ 1 - \tfrac{5}{6} e^2 + \ldots\ldots &= Y_2, \text{ etc.} \end{aligned}$$

we obtain

$$\begin{aligned} \frac{dz}{dt} &= \mu\,a \sin i\,(Y_1 \cos \omega \cos M - X_1 \sin \omega\,.\sin M) \\ &\quad + \mu\,e\,a \sin i\,(Y_2 \cos \omega \cos 2\,M - X_2 \sin \omega \sin 2\,M) \\ &\quad + \ldots\ldots\ldots \end{aligned} \tag{9}$$

If in this we set

$$X_1 \sin \omega = b_1 \sin \beta_1 \qquad X_2 \sin \omega = b_2 \sin \beta_2$$
$$Y_1 \cos \omega = b_1 \cos \beta_1 \qquad Y_2 \cos \omega = b_2 \cos \beta_2 \qquad (10)$$

we have

$$\frac{dz}{dt} = b_1 \mu a \sin i \cos (M + \beta_1)$$
$$+ b_2 \mu e a \sin i \cos (2 M + \beta_2)$$
$$+ \ldots\ldots\ldots$$

Substituting in (4) and remembering that $M = M_0 + \mu \ (t - t_0)$ we obtain

$$V = \gamma + \mu a \sin i . b_1 . \cos [\mu \ (t - t_0) + M_0 + \beta_1]$$
$$+ \mu e a \sin i . b_2 . \cos [2 \mu (t - t_0) + 2 M_0 + \beta_2] \qquad (11)$$
$$+ \ldots\ldots\ldots$$

This is our desired expression for the velocity in terms of the elements and of the time.

The series (2) and (11), considered as functions of the time, are of the same form. If they are to represent the same quantity, their corresponding coefficients must be equal. That is, we must have

$$\gamma = a_0$$
$$b_1 \mu a \sin i = a_1 \qquad M_0 + \beta_1 = \alpha_1$$
$$b_2 \mu e a \sin i = a_2 \qquad 2 M_0 + \beta_2 = \alpha_2 \qquad (12)$$

Neglecting terms involving e these reduce to

$$a \sin i = \frac{a_1}{\mu} \qquad M_0 = \alpha_2 - \alpha_1$$
$$e = \frac{a_2}{a_1} \qquad \omega = 2 \alpha_1 - \alpha_2 \qquad (13)$$

It is clear that equations (13) give accurate values of the elements only when e is very small. But, in any case, they give approximate values of e and ω, by the use of which in the complete equations newer and more accurate values of the elements may be deduced.

Example.

Let the number of parts into which the period is divided be twelve.

We find

$\gamma = c_0 = -16 \cdot 9^{\text{kms}}$ per sec.

$c_1 = +29 \cdot 253 \qquad s_1 = +23 \cdot 465$

$c_2 = -\ \ 2 \cdot 692 \qquad s_2 = +15 \cdot 055$

and hence

$a_1 = 37 \cdot 500$

$a_2 = 15 \cdot 294$

from which the preliminary value of e is $0 \cdot 4078$

also $\alpha_1 = 321° \ 16'$

$\alpha_2 = \ \ 79° \ 52'$

from which the preliminary value of

ω is $202° \ 20'$

Using the above values of e and ω as first approximations, and solving the complete equations we find

$e = 0 \cdot 422$

$\omega = 201° \ 09'$ measured from the descending node.

$a \sin i = 29{,}291{,}700^{\text{kms}}$.

Summary of Values.

	e	ω
Lehmann-Filhes	0·438	19° 27′
Schwarzschild	0·427	18° 37′
Zurhellen No. 1	0·432	17° 25′
" No. 2	0·431	17° 38′
" No. 3	0·490	17° 25′
" No. 4	0·432	17° 25′
" No. 5	0·358	20° 17′
" No. 6	0·249	21° 12′
" No. 7	0·415	19° 2′
(Control)	0·434	
" No. 8	0·428	19° 54′
Russell	0·422	21° 09′

If we take the mean of all values we get

$e = 0{\cdot}413 \qquad \omega = 19° \; 3'$

If the values of 3, 5, 6 which are not suitable for this orbit be omitted we get

$e = 0{\cdot}429 \qquad \omega = 18° \; 50'$

which may be considered as very close approximations to their true values.

Similarly taking means of the determinations of time of periastron passage we get it very nearly $T = 9{\cdot}0$ days = July 11·0. For $a \sin i$, the mean of the three determinations of 29,763,000, 29,936,000 and 29,292,000 is 29,664,000$^{\text{kms}}$.

The final values for the elements of αDraconis may therefore be put as above, in the confidence that they represent the observations very closely.

i ORIONIS.

i Orionis R.A. $5^h\,30{\cdot}5^m$, Decl.—5° 59′, Magnitude Visual 2·8, Phot. 3·4, Spectrum of Orion type with broad and diffuse lines, has been under observation here from the beginning of December, 1906, until it was too near the sun for satisfactory observation in April of this year. In all 45 spectrograms have been secured, of which 43, all that were suitable for measurement, have been reduced. All the spectra were made with the Brashear spectroscope, but it is proposed to continue the observations with the new single prism instrument as soon as possible. The spectra are of very poor quality for measurement, the lines being very diffuse and of non-symmetrical character, which may possibly be due to a second spectrum. As there are, in general, only two measurable lines on the plates λ4471 and λ4341, the resulting measures are subject to considerable uncertainty, and if it were not for the large range of velocity it would be hopeless to attempt any determination of the elements.

As it is, sufficient observations have not yet been obtained for a good curve, but it has been considered advisable to give those already obtained and to draw a provisional velocity curve, leaving its discussion and correction until further observations have been secured. It is hoped that, with the new single prism instrument, several more lines will be measurable and that the smaller linear dispersion will not, owing to the diffuseness of the lines, appreciably diminish the accuracy of measurement of any single line, while the probable error of the velocity should be considerably reduced, and, with a large number of observations, satisfactory elements obtained.

As with α Draconis, the Journal of Observations is followed by the separate measures and this is succeeded by a table containing ours and previous measures with the phase, corresponding to a period of 29·12 days, which seems to agree best with the observations. The resulting velocity curve is given in fig. 8, and shows some large deviations in the measurements. It is especially incomplete in its descending

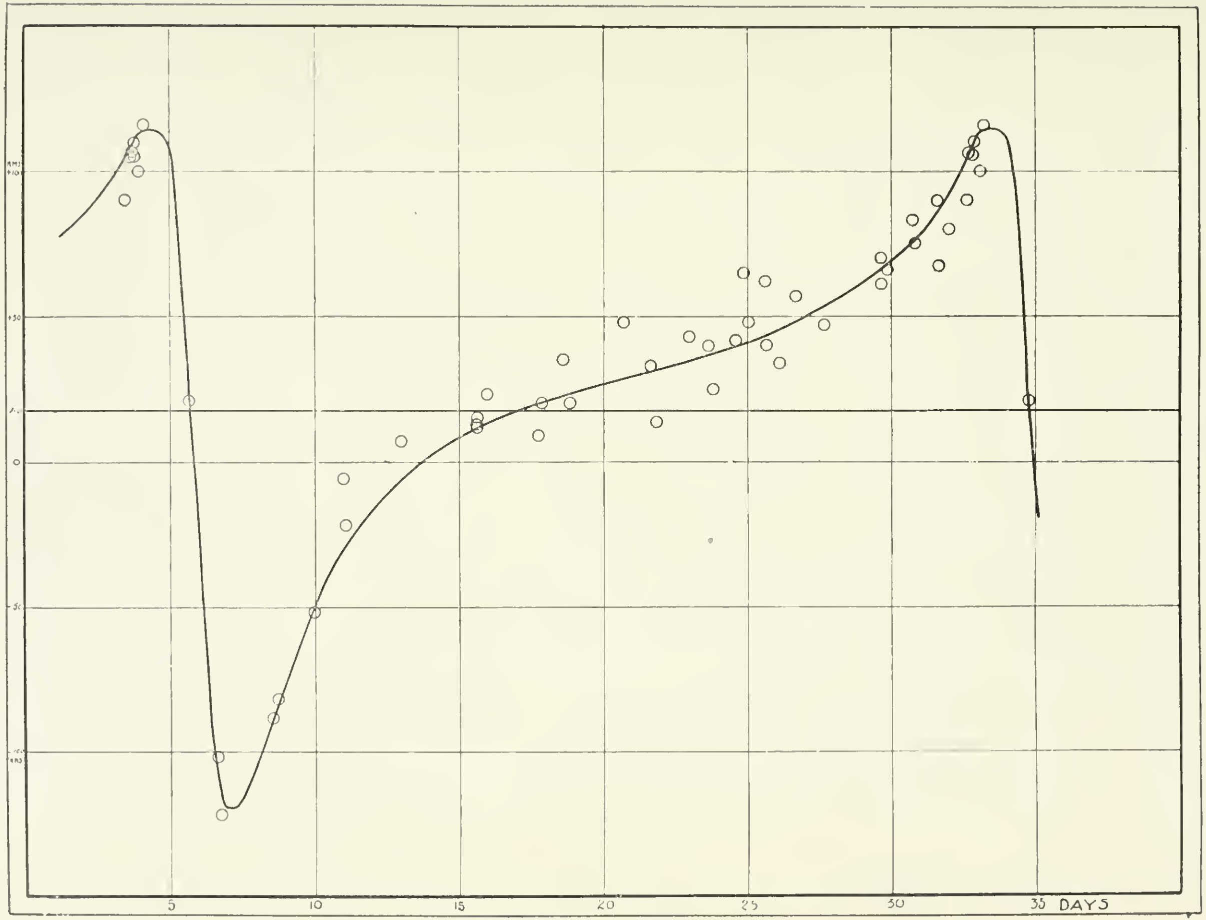


Fig. 8.—Velocity Curve of ι Orionis.

branch as, even after we had discovered its nature and the need of observations at that epoch, the weather was always unfavourable, and we were unable to secure them.

A preliminary determination of the elements by the method of Lehmann-Filhés gave for e about 0·75, and ω about 105°, but no great dependence can be placed on these values owing to the uncertainty in the form of the curve at maximum and minimum.

RECORD OF SPECTROGRAMS.

Star.	Number of Negative.	Plate.	Date.	Middle of Exposure.	Duration.	Hour Angle at End.	Comparison Spectrum. Beg.	Comparison Spectrum. End.	Comparison Spectrum. Kind.	Temperature. Room. Beg.	Temperature. Room. End.	Temperature. Prism Box. Beg.	Temperature. Prism Box. End.	Slit Width in m.m.	Focal Position. Star Focus.	Focal Position. Coll'r.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
			1906.	h m	m	h m	s	s		Fahr.	Fahr.	Cent.	Cent.							
ι Orionis.	453	Seed 27.	Dec. 11..	15 17	35	1 40 E.	20	20	Fe. Spark.	12·0	11·0	− 3·1	− 3·1	·030	19·0	15·2	5·68		H	
" ..	485	" 27.	" 18..	14	34	2 30 E.	20	20	"	12·2	12·0	− 1·4	− 1·5	·037	19·0	15·2	5·73		H	
			1907.																	
" ..	517	" 27.	Jan. 2..	15 05	30	25 E.	20	20	"	29·5	27·2	2·8	2·7	·030	19·0	15·2	5·71		P	
" ..	522	" 27.	" 9..	14 37	25	30 E.	20	20	"	7·8	8·0	−12·7	−12·7	·037	19·0	15·2	5·65		P	
" ..	535	" 27.	" 15..	15 20	34	40 W.	25	25	"	5·2	6·0	−12·8	−12·8	·037	19·0	15·2	5·65		H	
" ..	539	" 27.	" 16..	15 20	20	30 W.	20	20	"	− 2·0	− 2·0	−17·7	−17·7	·037	19·0	15·2	5·71	Unsteady.	H	
" ..	556	" 27.	" 18..	15 40	40	1 10 W.	20	20	"	9·0	7·5	− 8·0	− 8·0	·031	19·0	15·2	5·65	Fair.	P	
" ..	565	" 27.	" 21..	15 22	15	55 W.	20	20	"	5·8	6·2	−12·5	−12·5	·037	17·0	15·2	5·65		P	
" ..	585	" 27.	" 28..	14 50	20	1 00 W.	20	20	"	18·0	18·0	− 7·0	− 7·0	·037	17·0	15·2	5·65		H	
" ..	587	" 27.	" 30 .	12 32	25	1 15 E.	20	20	"	16·0	16·2	− 4·2	− 4·5	·037	17·0	15·2	5·67		H	
" ..	592	" 27.	" 30..	15 57	28	2 15 W.	20	20	"	10·0	9·8	− 4·5	− 5·0	·037	17·0	15·2	5·67		H	
" ..	594	" 27.	Feb. 4..	12 15	25	1 15 E.	20	20	"	10·0	10·0	− 6·7	− 7·0	037	17·0	15·2	5·67	Good	H	
" ..	601	" 27.	" 6..	15 15	20	2 00 W.	20	20	"	14·6	14·0	− 8·6	− 8·6	·031	20·5	15·2	5·65	"	P	
" ..	605	" 27.	" 7..	12 17	25	57 E.	20	20	"	17·5	17·0	− 2·5	− 3·0	·037	20·5	15·2	5·67	Unsteady.	H	
" ..	609	" 27.	" 12..	12 00	30	55 E.	20	20	"	14·0	12·0	− 9·3	− 9·3	·031	20·5	15·2	5·67	Good	H	
" ..	618	" 27.	" 21..	13 30	20	1 10 W.	20	20	"	11·7	11·7	− 5·1	− 5·1	·037	20·3	15·2	5·65	"	H	
" ..	627	" 27.	" 22..	15 00	20	2 45 W.	20	20	"	2·5	1·8	−14·8	−14·8	·031	20·3	15·2	5·65	"	P	
" ..	636	" 27.	" 25..	15 10	20	3 05 W.	20	20	"	10·4	10·8	− 7·8	− 7·8	031	20·5	15·2	5·65	Fair	P	
" ..	644	" 27.	" 27..	14 29	22	2 30 W.	20	20	"	12·4	—	− 2·8	− 2·8	·031	20·5	15·2	5·68	Good	P	
" ..	647	" 27.	Mar. 6..	12 19	24	50 W.	20	20	"	34·0	29·5	4·3	3·9	·037	20·5	15·2	5·70	Fair	P	
" ..	650	" 27.	" 6..	15 19	24	3 50 W.	20	20	"	22·5	22·0	3·9	3·9	·031	20·5	15·2	5·70	"	P	
" ..	653	" 27.	" 8..	12 31	20	1 15 W.	20	20	"	34·0	33·5	3·9	3·8	·031	20·5	15·2	5·70		P	
" ..	655	" 27.	" 8..	15 15	26	3 55 W.	20	20	"	28·5	28·5	3·1	3·2	·031	20·5	15·2	5·70		P	
" ..	659	" 27.	" 11..	12 52	25	1 45 W.	20	20	"	35·5	31·0	7·0	6·8	·031	20·5	15·2	5·72		P	
" ..	662	" 27.	" 11..	15 26	28	4 20 W.	20	20	"	32·0	32·0	6·9	6.9	·031	20·5	15·2	5·72		P	
" ..	665	" 27.	" 20..	12 32	25	2 00 W.	20	20	"	36·0	35·0	4·7	4·8	·037	20·5	15·2	5·70		P	
" ..	666	" 27.	" 20..	13 00	25	2 30 W.	20	20	"	35·0	34·2	4·8	4·8	·037	20·5	15·2	5·70	Good	P	
" ..	667	" 27.	" 20..	14 37	30	4 10 W.	20	20	"	32·3	31·5	3·8	3·8	·037	20·5	15·2	5·70	"	P	
" ..	672	" 27.	" 26 .	12 26	23	2 18 W.	25	25	"	46·0	45·0	11·0	11·0	·037	20·5	15·2	5·70		H	

" ..	673	"	27.	"	28..	12	27	25	2	18 W.	25	25	"	54·3	53·8	15·0	15·0	·037	20·5	15·2	5·76	....	H	Focus not exact(5·80)
" ..	678	"	27.	"	30..	12	50	20	3	05 W.	25	25	"	—	—	8·8	8·8	·031	20·5	15 2	5·76	......	P	
" .	680	"	27	April	1..	12	55	30	3	10 W.	25	25	"	33·7	32·0	4 8	5·0	·031	20·5	15·2	5·70	Better....	H	
" ..	686	"	27.	"	3..	12	50	25	3	15 W.	25	25	"	48·0	46·3	11·0	11·0	·031	20·5	15·2	5·72	....	P	
" ..	687	"	27.	"	3..	13	22	35	3	50 W.	25	25	"	46·2	42·8	11·2	11·2	·031	20·5	15·2	5·72	....	P	
" ..	693	"	27.	"	5..	12	30	20	3	00 W.	25	25	"	38·0	36·2	6·3	6·2	·031	18·2	15·2	5·70	Good.....	P	
" ..	695	"	27.	"	5..	13	19	22	3	50 W.	25	25	"	35·2	33·8	6·2	6·2	031	18·2	15·2	5·70	"	P	
" ..	702	"	27.	"	6..	12	26	23	3	00 W.	25	25	"	40·8	38·7	7·7	7·9	·037	18·2	15·2	5·73	"	H	
" ..	703	"	27.	"	6..	12	50	20	3	24 W.	25	25	"	38·7	39·0	7·9	8·1	·037	18·2	15·2	5·73	"	H	
" ..	705	"	27.	"	11..	12	46	57	3	55 W.	25	25	"	46·0	44·0	11·6	11·8	·037	18·2	15·2	5·73	Fair	H	Clouds 40m

ι ORIONIS 453.

1906. Dec. 11.
G. M. T. $15^h\ 17^m$

Observed by W. E. HARPER.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	S 65·3050	4494·738	....	....	......	....	2	54·6327	4383·751	....	·720	......	....
2	63·6260	4476·251	....	·185	.	....	1	50·2460	4342 207	·184	0·634	1·550	+106·95
1	63·3760	4473·550	·516	1·676	1·670	+123·75	3	48·4569	4325·961	....	·939	....	....
1	62·7450	4466·712	....	·727	......	....	3	S 46·4497	4308·081	....	....	....	.. ..
3	S 56·7836	4404 927	....	......	......	. ...							

Weighted mean	+115·35
V_a	+ 0·97
V_d	+ ·15
Curvature.... − ·50	
Radial velocity	+116·0

ι ORIONIS 485.

1906. Dec. 18.
G. M. T. 14^h

Observed by W. E. HARPER.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	S 68·3000	4528 798	....	..	......	....	3	S 56·7645	4404·927	....	.....	...	... .
2	65·2950	4494·731	....	·738	....	....	2	54·6105	4383·731	....	·720	......	... ...
2	63·6128	4476·237	....	·185	....	....	2	50·0173	4340·354	·361	·634	·273	− 18 84
1	63·1665	4471·400	·376	·676	·300	− 20·48	3	48 4320	4325 918	....	·939	...	... .
2	62·7319	4466·712	...	·727	.. ...	....	3	S 46 4305	4308 081	...	....	.....	... .

Weighted mean	−19·38
V_a	− 2·23
V_d .... + 0·22	
Curvature.....	− ·50
Radial velocity.	−22·0

ι ORIONIS 517.

1907. Jan. 2.
G. M. T. $15^h\ 05^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	S 68·3105	4528·798	...	....	....	....	3	S 56·7695	4404·927	...	......	...	....
2	65·3117	4494·795	....	·738	....	....	2	54·6066	4383 675	....	·720	.. .	... .
2	63·6162	4476·159	....	·185	....	....	2	50·1155	4341·312	·340	·634	·706	+48·71
2	63·2542	4472·233	·249	·676	·573	+38·39	3	48·4241	4325·943	. ..	·939	.....	....
2	62 7390	4466·679	....	·727	....	....	3	S 46·4146	4308·081	....	......	.... .	....

Weighted mean		+43·55
Va.	−9·00	
Vd..		+ ·04
Curvature........	− ·50	
Radial velocity................		+34·0

ι ORIONIS 522.

1907. Jan. 9.
G. M. T. $14^h\ 37^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave L ngth.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	S 65·3802	4494·738	....	......	.....	... .	2	54·7117	4383·727	....	·720	......	....
2	63·6979	4476·220	...	·185	.. ...	....	1	50·3174	4342·086	·084	0·634	1·450	+100·05
1	63·4597	4473·630	582	1·676	1·956	+127·70	3	48·5500	4325·944	....	·939	......	....
1	62·8282	4466·803	.. .	·727	. ...	... ..	3	S 46·5506	4308·081	...	. ...	.....	....
3	S 56·8620	4404 927	...	......	.....	....							

Weighted mean		+113·87
Va	−11·94	
Vd.......		+ ·04
Curvature......	− ·50	
Radial velocity.		+101·0

ι ORIONIS 535.

1907. Jan. 15.
G. M. T. 15^h 20^m

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·1450	4494·630	....	·738	.....	....	2	54·4781	4383·745	...	·720	.....	....
2	63·4580	4476·071	....	·185	.....	....	2	49·8657	4340·164	·084	·634	·550	− 37·95
1	62·9973	4471·074	·183	·676	·493	− 33·05	2	48·3160	4326·053	....	·939	....	......
1	62·5816	4466·590	..	·727	....	....	2	46·3146	4308·207	....	·081	....	.....
2	56·6277	4404·909	....	·927	.....	....							

Weighted mean	−	36·32
V_a	−	14·34
V_d	−	·04
Curvature	−	·50
Radia velocity..............	—	51·0

ι ORIONIS 539.

1907. Jan. 16.
G. M. T. 15^h 20^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2906	4494·650	...	·738	...	....	2	54·6468	4383·786	...	·720	....	......
1	63·6140	4476·171	....	·185	....	....	2	50·1247	4340·946	·834	·634	·200	+ 13·80
2	63·2075	4471·751	·736	·676	·060	+ 4·02	3	48·4957	4326·076	...	·939	..	......
2	62·7477	4466·779	....	·727	.....	....	3	46·4970	4308·189	....	·081	......	....
3	56·7975	4405·005	...	·927	......	....							

Weighted mean..............	+	8·91
V_a	−	14·61
V_d	−	·04
Curvature	−	·50
Radial velocity	−	6·0

ι ORIONIS 556

1907. Jan. 18.
G. M. T. 15h 40m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2792	4494·716	....	·738	......	....	3	54·6110	4383·721	...	·720	......	... .
2	63·6007	4476·235	....	·185	......	....	2	50·0800	4340·853	·884	·634	·250	+17·25
3	63·2246	4472·149	·066	·676	·390	+26·00	3	48·4410	4325·905	....	·939	....	....
2	62·7198	4466·996	....	·727	...	....	3	46·4395	4308·044	...	·081	......	... .
3	56·7650	4404·948	....	·927	.....	....							

Weighted Mean... .....+22·50
V_a........ −15·50
V_d........ − ·09
Curvature . − ·50

Radial velocity.......... +6·

ι ORIONIS 565

1907. Jan. 21.
G. M. T. 15h 22m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2580	4494·591	....	·738	.. .	....	3	56·7526	4404·992	.	·927	... .	....
2	63·5737	4476·063	....	·185	.....	. . ..	3	50·0999	4341·248	·117	0·634	·483	+33·35
2	63·2239	4472·265	·326	1·676	·700	+ 46·80	3	48·4416	4326·138	....	5·939	......	....
1	62·7016	4466·628	....	·727	......	....							

Weighted Mean.........+38·73
V_a........ −16 59
V_d.... ... − ·09
Curvature.. − ·50

Radial velocity..........+21·5

ι ORIONIS 585

1907. Jan. 28.
G. M. T. $14^h\ 50^m$

Observed by } W. E. HARPER.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2890	4494·780	....	·738	...	....	3	56·7705	4404·890	....	·927	....	....
2	63·6037	4476·208	....	·185	...	....	3	50·1731	4341·554	·634	0·634	1·000	+69.00
2	63·2590	4472·459	456	1·676	·780	+52·26	3	48·4519	4325·842	....	·939	......	....
1	62·7272	4466·709	....	·727	......	....							

Weighted mean........ +62·30
V_a .... −18·95
V_d .... − ·09
Curvature . − ·50

Radial velocity......... +42·8

ι ORIONIS 587

1907. Jan. 30.
G. M. T. $12^h\ 32^m$

Observed by } W. E. HARPER.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2770	4494·734	....	·738	......	....	2	54·6023	4383·728	....	·720	......	....
2	63·5903	4476·173	...	·185	......	....	½	50·1848	4341·940	·904	0·634	1·270	+ 87·63
1	63·2850	4472·911	·916	1·676	1·240	+82·96	2	48·4324	4325·964	.	·939	. .	....
2	62·7175	4466·727	....	·727	.....	....	2	46 4322	4308·126	....	·081	......	....
3	56·7573	4404·960	....	·927	....	....							

Weighted mean......... +84·83
V_a .... −19·54
V_a .... + ·12
Curvature . − ·50

Radial velocity......... +64·9

ι ORIONIS 592

1907. Jan. 30.
G. M. T. 15^h 57^m

Observed by / Measured by } W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3162	4494·740	....	·738	......	....	3	56·7975	4404·931	....	·927	....	....
2	63·6281	4476·155	....	·185	....	....	1	50·2020	4341·669	·674	0·634	1·040	+ 71·76
1½	63·3041	4472·633	·656	1·676	·980	+ 65·66	2	48·4745	4325·913	....	·939	......	... .
1	62·7615	4466·770	....	·727	......	....	3	46·4742	4308·068	....	·081	......	....

Weighted mean...... ... . + 68·10
V_a .... − 19·54
V_d .... − ·16
Curvature.. − ·50

Radial Velocity..... ... . + 47·9

ι ORIONIS 594

1907. Feb. 4.
G. M. T. 12^h 15^m

Observed by / Measured by } W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	65·3280	4494·815	....	·738	....	.. ..	3	56·8030	4404·815	..	·927	.. .	.. ....
1	63·6450	4476·258	. ..	·185	.. ..	....	2	50·2348	4341·723	·854	0·634	1·220	+ 84·18
2	63·3546	4473·098	·026	1·676	1·350	+ 90·45	3	48·4867	4325·758	....	·939	......	....
1	62·7750	4466·824	....	·727	.... .	....							

Weighted mean.......... ... . + 87·31
V_a .... − 20·99
V_d .... + ·12
Curvature.. − ·50

Radial Velocity... .... + 65·9

ι ORIONIS 601.

1907. Feb. 6.
G. M. T. 15^h 15^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2910	4494·702	....	·738	.....	....	3	56·7782	4404·867	...	·927	......	....
2	63·6068	4476·142	....	·185	......	....	2	50·2537	4342·200	.224	0·634	1·590	+109·70
3	63·4104	4474·000	·056	1·676	1·380	+92·46	3	48·4722	4325·926	....	·939	.. ..	....
1	62·7304	4466·642	....	·727	......	....							

Weighted Mean.............. +99·36
V_a .... −21·56
V_d .... − ·16
Curvature.... − ·50

Radial Velocity............. +77·1

ι ORIONIS 605.

1907. Feb. 7.
G. M. T. 12^h 17^m

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	65·2772	4494·749	....	·738	....	....	3	56·7609	4404·894	....	·927	......	... ...
1	63·5953	4476·217	....	·185	......	....	1	50·2386	4342 258	·304	0·634	1·670	+115·23
1	63·3719	4473·785	·786	1·676	2·110	+141·37	3	48·4462	4325·891	....	·939	......	....
1	62·7152	4466·678	...	·727	.... .	... .							

Weighted Mean......... .... +128·30
V_a .... −21·78
V_d .... + ·09
Curvature.... − ·50

Radial Velocity................+106·1

ι ORIONIS 609.

1907. Feb. 12.
G. M. T. 12ʰ

Observed by W. E. Harper.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2562	4494·615	....	·738	.....	....	3	56·7552	4404·937	....	·927	......	....
2	63·5802	4476·152	....	·185	......	....	2	49·9698	4339·881	·814	0·634	·820	−56·58
2	63·0791	4470·709	·756	1·676	·920	−61·64	3	48·4531	4326·054	....	·939	......	....
2	62·7036	4466·654	....	·727	...	......							

Weighted mean.........		−59·11
V_a		−22·96
V_d	+ ·09	
Curvature...........		− ·50
Radial velocity		− 82·5

ι ORIONIS 618.

1907. Feb. 21.
G. M. T. 13ʰ 30ᵐ

Observed by W. E. Harper.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	68·2651	4528·901	....	·798	......	....	3	56·7485	4404·971	...	·927	......	....
2	63·5820	4476·272	....	·185	....	....	2	50·1098	4341·272	·224	0·634	·590	+40·48
2	63·2031	4472·152	·086	1·676	·410	+27·47	3	48·4375	4326·003	....	·939	...	....
1	62·7051	4466·770	...	·727	...	....	3	46·4316	4308·104	...	·081	......	... .

Weighted mean..		+33·97
V_a	−24·65	
V_d	− ·09	
Curvature ..	− ·50	
Radial velocity		+ 8.7

ι ORIONIS 627.

1907. Feb. 22.
G. M. T. 15ʰ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·2750	4494·803	....	·738	.....	....	3	56·7835	4404·923	....	·927	.....	....
2	63·5942	4476·222	....	·185	......	....	2	50 1903	4341·443	·494	0·634	·860	+59·34
2	63·2302	4472·252	·206	1·676	·530	+35·51	2	48·4880	4325·859	....	·939	......	....
2	62·7271	4466·795	....	·727	......	....							

Weighted Mean		+47·42
V_a	−24·80	
V_d	− ·19	
Curvature........	− ·50	
Radial Velocity		+22·0

ι ORIONIS 636.

1907. Feb. 25.
G, M. T. 15ʰ 10ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3028	4494·734	.....	·738	......	....	3	56·7982	4404·967	.....	·927	.....	....
2	63·6207	4476·193	....	·185	....	....	2	50·1525	4341·164	1·064	0·634	·430	+29·67
2	63·2634	4472·307	2·276	1·676	·600	+40·20	2	48·4976	4326·065	.....	·939	....	....
1	62·7528	4466·784	.....	·727	.....	....							

Weighted Mean......		+33·93
V_a	−25·20	
V_d	− ·22	
Curvature......	− ·50	
Radial Velocity.....		+8·0

ι ORIONIS 644.

1907. Feb. 27.
G. M. T. 14^h 30^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3137	4494·805	....	·738	.....	....	3	56·7962	4404·897	....	·927	......	......
2	63·6314	4476·260	. .	·185	....	....	2	50·1809	4341·376	·464	·634	·830	+ 57·27
2	63·2898	4472·543	·466	·676	·790	+ 52·93	3	48·4790	4325·838	....	·939	....	....
1	62·7678	4466·900	...	·727	.....	....							

Weighted Mean..................		+55·10
V_a	− 25·42	
V_d	− ·19	
Curvature........	− ·50	
Radial Velocity..................		+ 29·0

ι ORIONIS 647.

1907. Mar. 6.
G. M. T. 12^h 19^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2869	4494·798	...	·738	......	....	3	56·7577	4404·914	...	·927	...	....
2	63·6104	4476·342	...	·185	..	......	2	50·2036	4342·063	·164	0 634	1·530	+105·57
½	63·3630	4473 653	·526	1·676	1·850	+ 123·95	2	48·4270	4325·865	....	·939	......	....
1	62·7353	4466·867	....	·727	......	....	3	46·4207	4307 975	....	8·081	......	....

Weighted Mean		+109·23
V_a	− 25·96	
V_d	− ·04	
Curvature........	− ·50	
Radial Velocity....................		+ 83·0

ι ORIONIS 650.

1907. Mar. 6.
G. M. T. 15ʰ 19ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·2700	4494·725	......	·738	.....	....	3	56·7494	4404·932	....	·927	.. ..	......
1	63·5987	4476·314	....	·185	.... .	....	2	50·1832	4341·976	1·984	0·634	1·350	+93·15
½	63 3615	4473·736	3·746	1·676	2·070	+138·69	3	48·4230	4325·929	.. .	·939	......	....
1	62·7115	4466·712	....	·727	.... .	....							

Weighted Mean .... +102·25
V_a .... −25·96
V_d .... − ·25
Curvature. .. − ·50

Radial velocity... 75·5

ι ORIONIS 653.

1907. Mar. 8.
G. M. T. 12ʰ 32ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3455	4494·897	.... .	·7?8	..	.. ....	3	56·8136	4404·922	.....	·927	..	....
2	63·6619	4476·352	...	·185	....	....	2	50·2928	4342·335	·444	0·634	1·810	+124·89
3	63·4322	4473·854	3·726	1·676	2·050	+137·35	3	48·4805	4325·798	....	9·39	.....	....
1	62·7820	4466·822	.....	·727	.. .	.. ..							

Weighted Mean....... . +132·36
V_a ... . −26·05
V_d .... − ·09
Curvature. . − ·50

Radial velocity............ +106·0

ι ORIONIS 655.

1907. March 8.
G. M. T. $15^h\ 15^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3094	4494·894	......	·738	.....	....	3	56·7705	4404·892	.....	·927	.....	....
2	63·6220	4476·317	....	·185	. ..	. ...	2	50·2558	4342·394	·494	0·634	1·860	+128.34
1	63·4127	4474·042	3·946	1·676	2·270	+152·09	3	48·4388	4325·821	.....	·939	......	... ...
1	62·7398	4466·767	.. ...	·727	....	....							

Weighted mean..		+136 26
V_a	−26 05	
V_d	− ·25	
Curvature....	− ·50	
Radial velocity...........		+109·5

ι ORIONIS 659.

1907. March 11.
G. M. T. $12^h\ 52^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3169	4494·928	.. ..	·738	.. .	....	3	56·7781	4404·917	......	·927	.....	....
2	63 6437	4476·505	.... ..	·185	....	....	2	49·9547	4339·574	·714	0·634	·920	−63·48
2	63·0960	4470·560	·41	1·676	1·260	−84.42	3	48·4382	4325·765	......	·939	......	... .
2	62·7562	4466 785	...	·727	... ..	... .							

Weighted mean.	−73·95
V_a	−26·12
V_d	− ·12
Curvature	− ·50
Radial velocity	−101·0

ι ORIONIS 662.

1907. Mar. 11.
G. M. T. 15h 26m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
1	65·3272	4494·892	...	·738	. .	. ...	3	56·7865	4404·851	. ..	·927	...	....
1	63·6463	4476·383	...	·185	......	....	1	49·9173	4339·078	254	0·634	1·380	−95·22
1	63·0936	4470·384	·256	1·676	1·420	−95 14	3	48·4512	4325·733	...	·939	.....	....
1	62 7725	4466·919	....	·727	....	....							

Weighted Mean .... − 95·18
V_a........ .... − 26·12
V_d.... .... − ·28
Curvature...... − .50

Radial velocity... ... − 122·0

ι ORIONIS 665.

1907. Mar. 20.
G. M. T. 12h 32m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3009	4494·799	...	·738	......	.. ..	3	56·7648	4404 835	....	·927	. ....	....
2	63·6134	4476·225	....	·185	....	....	3	50·1227	4341·168	·328	·634	·694	+47·88
2	63·2358	4472 123	·091	1·676	·415	+27·80	3	48 4338	4325·776	....	·939	.....	....
2	62·7376	4466·744	....	·727	......	....							

Weighted Mean .... +39·85
V_a. .. .... −25·90
V_d......... − ·16
Curvature... − ·50

Radial velocity......... . . +13·3

ι ORIONIS 666.

1907. March 20.
G. M. T. 13^h

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3077	4494·875	....	·738	.....	....	3	56·7690	4404·877	....	·927	.. .	....
2	63·6172	4476·266	....	·185	.... ..	....	2	50·1226	4341·167	·269	0·634	·635	+43·81
2	63·2563	4472·346	·266	1·676	·590	+39·53	3	48·4387	4325·820	....	·939	......	....
1	62·7410	4466·779	....	·727	......	....							

Weighted mean......... +41·67
V_a......... −25·90
V_d......... − ·19
Curvature.. − ·50

Radial velocity......... + 15·1

ι ORIONIS 667.

1907. March 20.
G. M. T. 14^h 37^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3222	4494·837	...	·738	.....	....	3	56·7823	4404·809	....	·927	.. .	....
2	63·6331	4476·239	....	185	......	....	2	50·1376	4341·105	·234	0·634	·600	+41·40
2	63·2648	4472·237	·176	1·676	·500	+33·50	3	48·4588	4325·801	....	·939	.....	....
2	62·7600	4466·785	....	·727	......	....							

Weighted mean... ..... +37·45
V_a......... −25·90
V_d........ − ·28
Curvature.. − ·50

Radial velocity......... + 10·8

ι ORIONIS 672.

1907. March 26.
G. M. T. 12h 26m

Observed by W. E. Harper.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	S 68·3301	4528·798	....	.....	......	. ....	3	S 56·7690	4404·927	....	. ..	. . . .	....
2	63·6232	4476·133	....	·185	......	....	2½	50·1415	4341·589	·574	·634	·940	+ 64·86
2	63·2755	4472·371	·406	·676	730	+ 48·91	3	S 46·4106	4308·081	....	.. .	......	....
2	62·7500	4466 713	....	·727	... .	....							

Weighted mean............ + 58·98
V_a .... − 25·41
V_d .... − ·16
Curvative. ...... − ·50

Radial velocity.............. + 33·0

ι ORIONIS 673.

1907. March 28.
G. M. T. 12h 27m

Observed by W. E. Harper.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3089	4494·944	...	·738	......	....	3	56·7476	4404·900	. .	·927	...	....
2	63·6109	4476·294	...	·185	......	....	3	50·1049	4341·342	·484	0·634	·850	+ 58·65
2	63·2999	4472·922	806	1·676	1·130	+ 76·71	2	48·3939	4325·776	....	·939		....
2	62·7339	4466·821	...	727	.....	....							

Weighted mean............ + 65·87
V_a .... − 25·18
V_d .... − ·19
Curvature. ..... − ·50

Radial velocity.............. + 40·0

ι ORIONIS 678.

1907, Mar. 30.
G. M. T. 12^h 50^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity	Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3161	4494·729	.....	·738	...	....	3	56·7667	4404·916	.....	·927	....	....
2	63·6137	4476·051	....	·185	.....	....	2	50·1699	4341·853	1·794	0·634	1·160	+80·04
2	63·3314	4472·995	3·096	1·676	1·420	+95·14	3	48·4262	4326·001	....	5·939	....	....
2	62·7415	4466·642	...	·727	...	....							

Weighted mean........		+87·59
Va..........	−25 00	
Vd..........	− ·22	
Curvature......	− ·50	
Radial velocity		+62·0

ι ORIONIS 680.

1907, April, 1.
G. M. T. 12^h 55^m

Observed by } W. E. Harper.
Measured by }

Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3222	4494·936	....	·738	.....	....	3	56·7902	4404·988	.....	·927	. . .	....
2	63·6281	4476·285	......	·185	.....	....	3	50·1877	4341·667	·724	0 634	1·090	+75·21
2	63·3080	4472·806	·686	1·676	1·010	+67·67	3	48·4519	4325·839	....	·939	...	... .
2	62·7557	4466·838	....	·727	.....	... .							

Weighted mean............		+72·20
Va............	−24·64	
Vd	− ·22	
Curvature......	− ·50	
Radial velocity		+46·8

ι ORIONIS 686.

1907. April 3.
G. M. T. $12^h 50^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	65·3298	4494·727	......	·738	......	....	3	56·7823	4404·921	......	·927	. . .	....
2	63·6424	4476·212	......	·185	......	... .	2	50·2157	4342·124	2·104	0·634	1·470	+101·43
2	63·3472	4473·015	2·996	1·676	1·320	+88·44	3	48·4398	4325·973	......	·939	.. .	....
2	62·7645	4466·739	....	·727	.....	.. ..							

Weighted mean............ +94·93
V_a .... −24·40
V_d .... − ·22
Curvature ..... − ·50

Radial velocity.......... ...+69·8

ι ORIONIS 687.

1907. April 3.
G. M. T. $13^h 22^m$

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3150	4494·667	...	·738	......	....	3	56·7720	4404·919	......	·927	......	....
2	63·6337	4476·218	....	·185	.. .	....	2	50·1852	4341·944	·924	0·634	1·290	+89·01
2	63·3294	4472·922	·926	1·676	1·250	+83·75	3	48·4285	4325·972	......	·939	....	.. ..
2	62·7527	4466·712	.....	·727	......	....							

Weighted mean .. .. +86·38
Va .... −24·40
Vd .... − ·25
Curvature..... − ·50

Radial velocity........ .....+61·2

ι ORIONIS 693.

1907. April 5.
G. M. T. 12h 30m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3042	4494·543	....	·738	.....	....	3	56·7750	4404·948	....	·927	...	....
2	63·6195	4476·065	...	·185	.....	....	2	50·2099	4342·170	·094	0·634	1·460	+100·74
3	63·3650	4473·308	·426	1·676	1·750	+117·25	2	48·4335	4326·017	....	5·939	....	......
2	62·7427	4466·605	....	·727	......	....							

Weighted Mean..........		+110·65
V_a	−23·99	
V_d	− ·22	
Curvature	− ·50	
Radial velocity...........		+86·0

ι ORIONIS 695.

1907. April 5.
G. M. T. 13h 19m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3224	4494·619	....	·738	.. ..	....	3	56·7897	4404·907	.....	927	......	......
2	63·6357	4476·101	...	·185	.....	....	1½	50·2048	4341·891	1·904	0·634	1·270	+87·63
2	63·3505	4473·010	·086	1·676	1·410	+94·47	3	48·4505	4325·927	.....	·939	.. ..	....
1	62·7617	4466·663	....	·727	......	....							

Weighted Mean		+91·54
V_a	−23·99	
V_d	− ·25	
Curvature	− ·50	
Radial velocity..........		+66·8

ι ORIONIS 702.

1907. April 6.
G. M. T. 12^h 26^m

Observed by W. E. HARPER.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3065	4494·643	..	·738	....	....	3	56·7705	4404·916	....	·927	.....	......
2	63·6195	4476·125	....	·185	..	....	2	50·2205	4342·236	·274	0·634	1·640	+113·16
2	63·3617	4473·332	396	1·676	1·720	+115·24	2	48·4238	4325·888	...	·939	.....	......
1	62·7431	4466·664	....	·727	...	....							

Weighted mean		+114·20
V_a	−23·80	
V_d	− ·22	
Curvature	− ·50	
Radial velocity		+ 89·7

ι ORIONIS 703.

1907. April 6.
G. M. T. 12^h 50^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
1½	65·3325	4494·731	....	·738	.....	....	3	56·7935	4404·944	....	·927	....	....
1½	63·6472	4476·225	.	·185	.....	.....	2	50·2682	4342·475	454	0·634	1·820	+125·58
2	63·4199	4473·761	·736	1·676	2·060	+138·02	3	48·4560	4325·977	....	·939	....	....
1	62·7571	4466·614	....	·727	......	....							

Weighted mean		+131·80
V_a	−23·80	
V_d	− ·22	
Curvature	− ·50	
Radial velocity		+107·3

ι ORIONIS 705

1907. April 11.
G. M. T. 12^h 46^m

Observed by W. E. Harper.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	65·3438	4494·732	....	·738	...	....	3	56·7920	4401·867	. ..	·927	....	....
2	63·6437	4476·072	...	·185	....	... .	3	49·9523	4339·557	·604	0·634	1·030	−71·07
2	63·1484	4470·714	·836	1·676	·840	−56·28	3	48·4466	4325·885	....	·939	......	....
2	62·7677	4466·585	....	·727	......	....							

Weighted mean............	−65·15
V_a	−22·80
V_d	− ·25
Curvature....	− ·50
Radial velocity...........	−88·7

ι ORIONIS.

Number of Neg.	Date.	G. M. T.	Velocity.	Number of Neg.	Date.	G. M. T.	Velooity.
	1906.	h m			1907.	h m	
453.................	Dec. 11..	15 ..	+116·	644................ .	Feb. 27..	14 ..	+ 25·
485............... .	" 18..	14 ..	− 22·	647..................	March 6..	12 ..	+ 8?·
				650	" 6..	15 ..	+ 75·
	1907.			653....	" 8..	12 ..	+106·
				655.............	" 8..	15 ..	+110·
517........	Jan. 2 .	15 ..	+ 34·	659	" 11..	12 ..	−102·
522........	" 9..	14 ..	+100·	662......	" 11..	15 ..	−122·
535.............	" 15..	15 ..	− 52·	665..................	" 20..	12 ..	+ 13·
539........	" 16..	15 ..	− 6·	666.......	" 20..	13 ..	+ 15·
556.	" 18..	15 ..	+ 7·	667............	" 20..	13½ ..	+ 11·
565	" 21..	15 ..	+ 23·	672............	" 26..	12 ..	+ 33·
585............	" 28..	15 ..	+ 43·	673	" 28..	12 ..	+ 40·
587................	" 30..	12 ..	+ 65·	678....	" 30..	12 ..	+ 62·
592........	" 30 .	16 ..	+ 48·	680.................	April 1..	13 ..	+ 47·
594........	Feb. 4..	12 ..	+ 66·	686..................	" 3..	13 ..	+ 70·
601	" 6 .	15 ..	+ 80·	687..................	" 3..	13½ ..	+ 61·
605.................	" 7..	12 ..	+106·	693.............	" 5..	13 ..	+ 85·
609........	" 12..	12 ..	− 82·	695.........	" 5..	13½ ..	+ 67·
618	" 21..	13 ..	+ 9·	702..................	" 6..	12 ..	+ 90·
627..........	" 22..	15 ..	+ 20·	703.....	" 6..	13 ..	+107·
636.............	" 25..	15 ..	+ 14·	705.............	" 11..	13 ..	− 89·

PREVIOUS OBSERVATIONS.

1903.	h	m		1903.	h	m	
September 5...........	22	29	+ 21	October 23..........	23	37	+ 42
" 25..........	21	58	+ 40	" 24.............	20	38	....
" 26..........	22	33	+ 57	" 30.............	20		+ 90
October 17...............	23	19	+ 35				

EFFECT OF SLIT WIDTH ON ERRORS OF SETTING.

The investigation on the character of the star image given by the combination of objective and correcting lens had shown that the effective diameter of such an image, so far as the transmission of light through the slit was concerned, was so large that the exposure required was very nearly inversely proportional to the slit width until this reached about $0 \cdot 15^{mm}$ between 5 and 6 seconds of arc. In order, therefore, to make use of the greater part of the starlight, a slit several times wider than is normally used would be required. As the purity of the spectrum diminishes in nearly the same ratio as the slit is opened, it is evident that for accurate work the width of slit is limited, and it was the purpose of this investigation to see how much the slit could be widened without increasing the probable error to a prohibitive degree.

Evidently this will depend partly upon the character of the star spectrum and partly upon the optical properties of the spectrograph. Leaving the latter out of consideration for the present, it is evident in stars of the solar type, where the spectrum is complex and most of the lines (with the small dispersion available) are blends, that any decrease in the purity will make the blends more complex and, besides making the error of setting larger, will increase the difficulty of identification and determination of the true wave lengths. Hence such spectra will not admit of much increase in slit width without great loss in accuracy. In the case of early type stars, however, where the lines are single, errors of identification are not likely to cause trouble and only the accidental errors of setting remain. The more diffuse the lines in the spectrum, the less will the probable error be increased by widening the slit within reasonable limits. As no experiments on this line had ever been undertaken, and as the question could not be decided by a theoretical discussion, it seemed worth while to make a number of spectra of the same star at different slit widths and see how the probable error of the velocity as obtained from a single line increased with the slit width.

The value of such work evidently lies in its bearing upon the range of the equipment, for if it is found that the radial velocity of a star can be obtained nearly as accurately with a slit $\cdot 063^{mm}$ as with a slit $\cdot 025^{mm}$ wide, it is evident that stars a magnitude fainter may be obtained and that all exposures are diminished by about 60 per cent.

The star chosen for the test was β Orionis, a helium star with moderately sharp helium and hydrogen lines and with some metallic lines. Five plates at each of five slit widths were made with the Brashear spectroscope, and the twenty-five plates were then measured by myself under similar conditions, using as far as possible the same lines throughout. Owing to the varying quality of the lines for measurement, they were weighted, and the weighted mean was used for determining the velocity and the weighted residuals for obtaining the probable errors. The measurements of the twenty-five plates follow.

RECORD OF SPECTROGRAMS.

Star.	No. of Neg.	Plate.	Date.	Middle of Exposure. — G. M. T.		Duration.	Hour Angle at End.		Comparison Spectrum.			Temperature.				Slit Width in Millimetres.	Focal Position.			Observer.
									Beg.	End.	Kind.	Room. Beg.	Room. End.	Prism Box. Beg.	Prism Box. End.		Star Focus.	Coll'r.	Camera.	
			1906.	h.	m.		h.	m.				Fahr.	Fahr.	Cent.	Cent.					
β Orionis...	463	Seed 27.	Dec. 17.	18	33	6	2	05 W	25	25	Fe. Spark.	17·0	17·0	−6·3	−6·3	·0254	19·0	15·2	5·73	P.
" ..	464	" 27.	" 17.	19	00	6	2	30 W	25	25	"	17·0	16·8	−6·3	−6·3	·0254	19·0	15·2	5·73	P.
" ..	465	" 27.	" 17.	19	07	6	2	40 W	25	25	"	16·8	16·8	−6·3	−6·3	·0254	19·0	15·2	5·73	P.
" ..	466	" 27.	" 17.	19	18	4	2	51 W	23	23	"	16·7	16·7	−6·3	−6·3	·0375	19·0	15·2	5·73	P.
" ..	467	" 27.	" 17.	19	24	4	2	56 W	23	23	"	16·7	16·6	−6·2	−6·2	·0375	19·0	15·2	5·73	P.
" ..	468	" 27.	" 17	19	31	4	3	04 W	23	23	"	16·6	16·6	−6·1	−6·1	·0375	19·0	15·2	5·73	P.
" ..	469	" 27.	" 17.	19	43	3	3	16 W	20	20	"	16·5	16·5	−5·9	−5·9	·0708	19·0	15·2	5·73	P.
" ..	470	" 27.	" 17.	19	48	3	3	22 W	20	20	"	16·5	16·5	−5·9	−5·9	·050	19·0	15·2	5·73	P.
" ..	471	" 27.	" 17.	19	56	3	3	28 W	20	20	"	16·5	16·5	−5·9	−5·9	·050	19·0	15·2	5·73	P.
" ..	472	" 27.	" 17.	20	04	2	3	36 W	18	18	"	16·5	16·5	−5·8	−5·8	·075	19·0	15·2	5·73	P.
" ..	473	" 27.	" 17.	20	09	2	3	42 W	18	18	"	16·5	16·5	−5·8	−5·8	·075	19·0	15·2	5·73	P.
" ..	474	" 27.	" 17.	20	13	2	3	47 W	18	18	"	16·5	16·5	−5·8	−5·8	·075	19·0	15·2	5·73	P.
" ..	494	" 27.	" 19.	15	19	6	1	00 E	25	25	"	13·4	13·0	−7·4	−7·4	·025	19·0	15·2	5·70	P.
" ..	495	" 27.	" 19.	15	27	6	0	54 E	25	25	"	13·0	12·0	−7·4	−7·4	·025	19·0	15·2	5·70	P.
" ..	496	" 27.	" 19.	15	40	4	0	40 E	23	23	"	12·0	11·5	−7·4	−7·4	·0375	19·0	15·2	5·70	P.
" ..	497	" 27.	" 19.	15	44	4	0	33 E	23	23	"	11·5	11·0	−7·4	−7·4	·0375	19·0	15·2	5·70	P.
" ..	498	" 27.	" 19.	15	54	3	0	25 E	20	20	"	11·0	10·8	−7·4	−7·4	·050	19·0	15·2	5·70	P.
" ..	499	" 27.	" 19.	15	59	3	0	20 E	20	20	"	10·8	10·6	−7·4	−7·4	·050	19·0	15·2	5·70	P.
" ..	500	" 27.	" 19.	16	07	$2\frac{1}{3}$	0	12 E	18	18	"	10·4	10·4	−7·4	−7·4	·0625	19·0	15·2	5·70	P.
" ..	501	" 27.	" 19.	16	12	$2\frac{1}{3}$	0	7 E	18	18	"	10·4	10·3	−7·4	−7·4	·0625	19·0	15·2	5·70	P.
" ..	502	" 27.	" 19.	16	20	$2\frac{1}{3}$	0	0	18	18	"	10·3	10·2	−7·4	−7·4	·0625	19·0	15·2	5·70	P.
" ..	503	" 27.	" 19.	16	24	$2\frac{1}{3}$	0	4 W	18	18	"	10·2	10·1	−7·4	−7·4	·0625	19·0	19·0	5·70	P.
" ..	504	" 27.	" 19.	16	31	$2\frac{1}{2}$	0	12 W	18	18	"	10·1	10·0	−7·4	−7·5	·0625	19·0	19·0	5·70	P.
" ..	505	" 27.	" 19.	16	37	2	0	18 W	18	18	"	10·0	10·0	−7·4	−7·5	·075	19·0	19·0	5·70	P.
" ..	506	" 27.	" 19.	16	41	2	0	22 W	18	18	"	10·0	10·0	−7·5	−7·6	·075	19·0	19·0	5·70	P.

β ORIONIS 463.
Slit ·025.

1906. Dec. 17.
G. M. T. 18h 33m

Observed by J. S. PLASKETT.
Measured by J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	72·8657	4584·396	.....	4·018	....	....	2	62·6806	4467·042	......	7·727	....	....
3	70·0181	4549·960	.....	9·642	....	....	3	56·7140	4405·174	......	5·927	...	....
2	65·2394	4495·055	...	5·738	...	....	1	55·0437	4388·666	8·416	8·100	·316	21·58
3	64·0587	4482·013	1·700	1·400	·300	+20·07	2	50·0231	4341·019	0·834	0·634	·200	+13·80
2	63·5534	4476·493	......	6·185	....	....	3	48·3893	4326·122	......	6·939	....	....
2	63·1691	4472·319	2·006	1·676	·330	22·11	3	46·3865	4308·248	...	8·081	....	....

Weighted mean.........	+19·08
V_a	− 4·59
V_d	− ·16
Curvature...	− ·50
Radial velocity..........	+13·8

β ORIONIS 464.
Slit ·025.

1906. Dec. 17.
G. M. T. 19h

Observed by J. S. PLASKETT.
Measured by J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	72·8364	4584·035	....	·018	....	......	2	63·1336	4471·934	·979	·676	·303	20·30
½	72·8603	4584·330	·313	·018	·295	+19·23	3	56·6786	4404·821	....	·927	....	....
2	69·9855	4549·574	....	·642	.....	....	½	54·9962	4388·201	313	·100	·213	14·54
3	65·2061	4494·684	...	·738	.....	....	1½	49 9969	4310·778	908	·634	·274	+18·90
3	64·0273	4481·669	·713	·400	·313	20·93	3	48·3557	4325·819	....	·939	......	....
3	63·5214	4476·145	....	·185	......	....	3	46·3512	4307·936	....	·081	......	....

Weighted Mean.......	+19·82
V^a	− 4·59
V_d.......	− ·19
Curvature.	− ·50
Radial velocity.....	+14·5

β ORIONIS 465.

Slit ·025.

1906. Dec. 17.
G. M. T. 19h 07m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8405	4584·086	...	·018	.....	....	1½	62·6541	4466·757	....	·727	......	....
1	72·8449	4584·153	·088	·018	·070	....	S 3	56·6892	4404·927	....	......	.....	......
S 2	69·9912	4549·642	..	....	.....	....	½	55·0195	4388·429	·430	·100	·330	22·53
2	65·2117	4494·747	....	·738	......	....	2	50·0140	4340·936	·920	·634	·286	+20·42
3	64·0275	4481·671	·650	·400	·250	+16·72	3	48·3713	4325·960	....	·939	....	.....
2	63·5265	4476·200	....	·185	......	....	S 3	46·3676	4308·081	....	....	.....	....
2	63·1460	4472·068	·046	·676	·370	25·79							

Weighted Mean......	+20·51
V_a	−4·59
V_d	− ·19
Curvature..	− ·50
Radial velocity.......	+15·2

β ORIONIS 466.

Slit ·0375.

1906. Dec. 17.
G. M. T. 19h 18m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8289	4583·943	...	·018	.	....	2	62·6451	4466·660	..	·727	......	....
¼	72·8700	4584·449	·518	·018	·500	+32·60	3	56·6795	4404·829	....	·927	...	....
2	69·9821	4549·534	..	·642	......	....	⅓	55·0233	4388·466	·570	·100	·470	32·10
2	65·1958	4494·570	....	·738	......	....	1½	49·9981	4340·789	·894	·634	·260	+17·94
3	64·0246	4481·639	·710	·400	·310	20·73	3	48·3570	4325·830	.. .	·939	....	....
3	63·5150	4475·114	....	·185	.....	....	3	46·3520	4307·943	....	·081	....	....
2	63·1400	4472·004	·076	·676	·400	26·80							

Weighted Mean	+23·02
V_a	−4·59
V_d	− ·22
Curvature..	− ·50
Radial velocity... ..	+17·7

β ORIONIS 467.

Slit ·0375.

1906. Dec. 17.
G. M. T. 19h 24m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	72·8329	4583·992	...	·018	....	....	2	63·1466	4472·075	·051	·676	·375	25·12
¼	72·8457	4584·150	·178	·018	·160	+10·43	3	56·6872	4404·906	....	·927	....	....
2	69·9900	4549·627	...	·642	....	....	½	55·0150	4388·385	·400	·100	·300	20·49
3	65·2085	4494·711	...	·738	.....	....	2	49·9975	4340·784	·796	·634	·162	+ 11·17
2½	64·0397	4481·865	·780	·400	·380	26·68	3	48·3670	4325·920	....	·939	....	....
3	63·5300	4476·238	....	·185	.....	....	3	46·3627	4308·037	..	·081	......	....

Weighted Mean.......	+20·98	
Va..............		– 4·59
Vd..............		– ·22
Curvature...... .		– ·50
Radial velocity........	+15·7	

β ORIONIS 468.

Slit ·0375.

1906. Dec. 17.
G. M. T. 19h 31m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	72·8397	4584·076	...	·018	.....	....	1½	62·6520	4466·735	....	·727	......	....
¼	72·8672	4584·416	·358	·018	·340	+ 22·16	3	56 6890	4404·925	..	·927	....	.....
2	69·9926	4549·658	....	·642	......	....	½	55·0233	4388·466	·466	·100	·366	25·00
3	65·2122	4494·752	....	·738	....	....	1½	50·0083	4340·884	·884	·634	·250	+ 17·25
2½	64 0378	4481·784	·776	·400	·376	25·15	3	48·3690	4325·939	...	·939	......	....
2	63 5259	4476·194	....	·185	....	....	3	46·3665	4308·072	....	·081	.....	....
2	63·1438	4472·044	·036	·676	·360	24·12							

Weighted Mean....	+22·96	
Va..............		– 4·59
Vd..............		– ·22
Curvature........		– ·50
Radial velocity........	+17 6	

β ORIONIS 469.

Slit ·05.

1906. Dec. 17.
G. M. T. 19^h 43^m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8265	4583·913	...	·018	......	... .	1	62·6459	4466·669	....	·727	.....	....
¼	72·8595	4584·320	·425	·018	·407	+ 26·53	3	56·6822	4404·856	....	·927	.....	....
2	69·9871	4549·593	....	·642	.....	....	¼	55·0372	4388·602	·674	·100	·574	39·20
1½	65·2035	4494·655	....	·738	......	....	1	49·9881	4340·698	·794	·634	·160	+ 11·04
2½	64·0160	4481·546	·610	·400	·210	14·04	3	48·3586	4325·845	....	·939	.....	....
2	63·5205	4476·135	....	·185	... .	....	3	46·3551	4307·970	...	·081	. ...	... .
1½	63·1329	4471·927	·983	·676	·307	20·56							

Weighted mean......	+ 16·98	
V_a		− 4·59
V_d		− ·22
Curvature .		− ·50
Radial velocity......	+ 11·7	

β ORIONIS 470.

Slit ·05.

1906. Dec. 17.
G. M. T. 19^h 48^m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8250	4583·895	....	·018	......	....	1	62·6381	4466·585	....	·727	.....	.. ....
¼	72·8520	4584·268	·388	·018	·370	+ 24·12	3	56·6760	4404·795	...	·927	.....	....
2	69·9766	4549·568	....	·642	......	....	¼	55·0253	4388·487	·620	·100	·520	35·51
2	65·2616	4494·634	....	·738	......	....	1½	50·0005	4340·811	·984	·634	·350	+ 24·15
3	64·0228	4481·620	·716	·400	·316	21·14	3	48·3521	4325·787	....	·939	......	....
1½	63·5176	4476·103	..	·185	......	....	3	46·3482	4307·910	....	·081	......	....
1½	63·1297	4471·892	·002	·676	·326	21·84							

Weighted Mean.. ...	+ 22·82	
V_a		− 4·59
V_d		− ·22
Curvature..		− ·50
Radial velocity..	+ 17·5	

β ORIONIS 471.

Slit ·05.

1906. Dec. 17.
G. M. T. 19^h 56^m

Observed by } J. S. Plaskett.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8246	4583·890	.. .	·018	......	....	1	62·6389	4466·594	....	·727	.....	....
½	72·8530	4584·239	·368	·018	·350	+22·82	3	56·6806	4404·840	....	·927	.....	....
1	69·9873	4549·595	....	·642	....	....	1	49·9974	4340·783	·904	·634	·270	18·63
2	65·2017	4494·636	....	·738	. ...	....	¼	55·0233	4388·466	·600	·100	·500	+34·15
3	64·0180	4481·567	·670	·400	·270	18·06	3	48·3562	4325·823	....	·939	......	....
2	63·5168	4476·094	....	·185	.....	... .	3	46·3552	4307·972	....	·081	.... .	....
2	63·1297	4471·892	·006	·676	·330	22·01							

Weighted mean...... ...+20·26
V_a .. .. −4·59
V_d .... − ·19
Curvature .... − ·50

Radial velocity..........+15·0

β ORIONIS 472.

Slit ·075.

1906. Dec. 17.
G. M. T. 20^h 04^m

Observed by } J. S. Plaskett.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8363	4584·034	....	·018	....	.. ..	½	62·6448	4466·657	....	·727	......	....
1½	69·9915	4549·645	...	·642	....	....	3	56·6827	4404·862	....	·927	......	. ...
2	65·2091	4494·717	....	·738	.....	....	1½	50·0209	4341·000	·084	·634	·450	+31·05
2	64·0271	4481·634	·690	.400	·290	+19·40	3	48·3607	4325·864	....	·939	......	....
1½	63·5184	4476·112	.. .	·185	.....	....	3	46·3538	4307·959	....	·081	.....	....
1	63·1460	4472·285	·349	·676	·673	45·09							

Weighted mean ....+28·99
V_a ... . −4·59
V_d .... − ·25
Curvature .... − ·50

Radial velocity ....+23·6

β ORIONIS 473.

Slit ·075.

1906. Dec. 17.
G. M. T. 20^h 09^m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	72·8672	4584·415	....	·018	.....	....	1	62 6725	4466·955	....	·727	......	....
2	70·0161	4549·936	....	·642	.....	.. ..	3	56·7185	4405·219	. .	·927	......	....
1½	65·2359	4495·016	....	·738	....	....	¼	55·0624	4388·849	569	·100	·469	32·03
2	64·0521	4481·941	·685	·400	·285	+19·06	1	50·0216	4341·006	·766	·634	·132	+9·11
1	63·5490	4476·445	...	·185	....	....	3	48·3930	4326·156	....	·939	. ...	....
1	63·1724	4472·355	·110	·676	·334	22·37	3	46·3905	4308·283	....	·081	......	... .

Weighted mean..........	+18·26
Va..................	− 4·59
Vd.........	− ·25
Curvature.............	− ·50
Radial velocity......	+12·9

β ORIONIS 474.

Slit ·075.

1906. Dec. 17.
G. M. T. 20^h 13^m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	72·8345	4584 012	....	·018	.....	... .	½	62·6359	4466·562	....	·727	.. ...	....
1	69·9864	4549·584	....	·642	.....	....	3	56·6780	4404·815	....	·927	.....	....
1	65·1895	4494·500	. ..	·738	......	....	¼	54·9865	4388·106	·210	·100	·110	7·51
3	64·6260	4481·655	·740	·400	·340	+22·74	2	49·9938	4340·750	·834	·634	·200	+13·80
1	63·5190	4476·119	....	·185	......	....	3	48·3598	4325·856	....	·939	......	....
1	63·1262	4471·854	·936	·676	·260	17·42	3	46·3567	4307·985	....	·081	....	....

Weighted mean..	+18·26
Va.....	− 4·59
Vd.......	− ·19
Curvature...	− ·50
Radial velocity...........	+13·0

β ORIONIS 494.

Slit ·025.

1906. Dec. 19.
G. M. T. 15ʰ 19ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8247	4584·180	....	·018	.....	....	2	62·6524	4466·898	....	·727	......	....
$\frac{1}{4}$	72·8590	4584·603	·441	·018	·423	+27·57	3	56·6875	4405·032	....	·927	......	....
1	69·9854	4549·814	...	·642	.....	....	$\frac{1}{4}$	55·0454	4388·799	·680	·100	580	39·61
2	65·2063	4494·868	...	·738	......	....	2	50·0097	4341·005	·854	·634	·220	+15·18
3	64·0383	4481·961	·850	·400	·450	30·10	2	48·3740	4326·094	....	·939	.....	....
2	63·5177	4476·271	....	·185	....	....	3	46·3695	4308·209	....	·081	....	....
$1\frac{1}{2}$	63·1623	4472·408	·286	·676	·610	40·87							

Weighted Mean ... +28·39
V_a .... −5·42
V_d .... + ·09
Curvature.. − ·50

Radial velocity ..... +22·6

*β ORIONIS 494.

Slit ·025.

1906. Dec. 19.
G. M. T. 15ʰ 19ᵐ

Observed by } J. S. Plaskett.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8210	4584·134	...	·018	.....	....	2	62·6388	4466 751	....	·727	......	....
$\frac{1}{4}$	72·8493	4584·484	·368	·018	·350	+22·82	3	56·6789	4404·946	...	.927	.....	....
2	69·9800	4549·751	....	·642	.....	....	1	55·0326	4388 674	·656	·100	·556	37·97
3	65·1989	4494·785	....	·738	......	....	2	50·0078	4340·988	·964	·634	·330	+22 77
4	64·0307	4481·877	·833	·400	·433	28·96	3	48·3600	4325 967	....	·939	....	....
3	63·5150	4476·241	...	·185	.	....	3	46·3556	4308·087	....	·081	....	....
3	63·1482	4472·255	·206	·676	·530	35·51							

* Check measurement.

Weighted Mean...... +29·91
V_a ... .. −5·42
V_d .... + ·09
Curvature.. − ·50

Radial velocity....... +24 1

β ORIONIS 495.

Slit ·025.

1906. Dec. 19.
G. M. T. 15ʰ 27ᵐ

Observed by J. S. PLASKETT.
Measured by J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
3	72·8437	4584·414	...	·018	.. ..	....	2	62·6598	4466·977	...	·727	...	....
¼	72·8604	4584·620	·224	·018	·206	+13·43	3	56·6974	4405·131	....	·927	......	....
2	69·9988	4549·974	....	·642	.. ..	....	½	55·0340	4388·688	·488	·100	·388	27·18
3	65·2232	4495·056	....	·738	......	....	1½	50·0181	4341·083	·874	·634	·240	+16·56
3	64·0355	4481·930	·690	·400	·290	19·40	3	48·3806	4326·153	....	·939	....	......
3	63·5348	4476·457	....	·185	......	......	3	46·3770	4308·275	...	·081	.....	....
2½	63·1569	4472·349	·086	·676	·410	27·47							

Weighted Mean............ ..	+21·76	
V_a		−5·42
V_d	+ ·09	
Curvature................		− ·50
Radial velocity	+15·9	

β ORIONIS 496.

Slit ·0375.

1906. Dec. 19.
G. M. T. 15ʰ 40ᵐ

Observed by J. S. PLASKETT.
Measured by J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement	Velocity	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	72·8432	4584·408	....	·018	...	....	1½	62·6507	4466·879	....	·727	... .	....
¼	72·8715	4584·758	·368	·018	·350	+22·82	3	56·6956	4405·113	....	·927	...	....
2	69·9928	4549·902	...	·642	.....	....	1½	50·0168	4341·070	·910	·634	·276	+19·04
2	65·2142	4494·956	....	·738	..... .	.. ..	3	48·3736	4326·090	...	·939	......	....
2½	64·0390	4481·968	·770	·400	·370	24·75	3	46·3755	4308·262	...	·081	....	....
2	63·5298	4476·402	.	·185	.. ..	....							

Weighted Mean	+22·62	
V_a......................		−5·42
V_d..	+ ·04	
Curvature..............		− ·50
Radial velocity..............	+ 16·7	

β ORIONIS 497.

Slit ·0375.

1906. Dec. 19.
G. M. T. 15h 44m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	69·9746	4549·686	....	·642	.....	....	1½	62·6392	4466·755	....	·727	....	....
3	64 0218	4481·780	·760	·400	·360	+ 24·08	½	55·0242	4388·592	·600	·100	·500	34·15
2	63·5123	4476·211	....	·185	......	....	1	50·0015	4340·930	·924	·634	·290	+ 20·01
1½	63·1347	4472·109	·086	·676	·410	27·47	3	48·3594	4325·962	....	·939	....	....

Weighted Mean......	+ 25·09	
V_a		−5·42
V_d	+ ·04	
Curvature .		− ·50
Radial velocity.......	+ 19·2	

β ORIONIS 498.

Slit ·05.

1906. Dec. 19.
G. M. T. 15h 54m

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8427	4584·402	....	·018	.....	....	1	62·6571	4466·948	....	·727	....	....
¼	72·8702	4584·734	·354	·018	·336	+ 21 90	3	56·7000	4405·157	....	·927	.....	....
2	70·0056	4550·055	....	·642	... ..	....	¼	55·0338	4388·686	·466	·100	·366	25·00
2	65·2146	4494·961	....	·738	......	....	1½	50·0112	4341·019	·814	·634	·180	+ 12·42
2½	64·0422	4482·003	·767	·400	·367	25·22	3	48·3775	4326·125	....	·939	.. ..	....
2	63·5338	4476·446	....	·185	.....	....	3	46·3761	4308·268	....	·081	....	....
1½	63·1656	4472·444	·216	·676	·540	36·18							

Weighted Mean......	+ 24·61	
V_a		−5·42
V_d	+ ·04	
Curvature .		− ·50
Radial velocity.......	+ 18·7	

β ORIONIS 499.

Slit ·05.

1906. Dec. 19.
G. M. T. 15h 59m

Observed by / Measured by } J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	69·9969	4549 952	....	·642	.....	....	3	56 7004	4405·161	....	·927	.....	... .
3	65·2120	4494·932	....	·738	.....	....	¼	55·0456	4388·801	·560	·100	·460	31·41
2½	64·0510	4482·100	870	·400	·470	+31·44	1½	50·0141	4341·046	·814	·634	·180	+12·42
2	63·5304	4476·403	. ..	·185	......	... .	3	48·3821	4326·167	....	·939	......	....
1½	63·1693	4472·484	·212	·676	·536	35·91	3	46·3785	4308·288	....	·081	. . .	....
1	62·6708	4467·095	....	·727	.. ..	....							

Weighted mean..........	+27·64	
V_a		−5·42
V_d	+ ·04	
Curvature		− ·50
Radial velocity..........	+21·7	

β ORIONIS 500.

Slit ·0625.

1906. Dec. 19.
G. M. T. 16h 07m

Observed by / Measured by } J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
3	72·8407	4584·377	.. .	·018	......	....	1	62·6531	4466·905	...	·727	..	....
3	69·9912	4549·884	.. .	·642	.... .	....	3	56 6972	4405·129	..	·927	......	....
2	65·2176	4494·995	...	·738	......	....	¼	55·0072	4388·426	·216	·100	·116	7·92
1½	64·0303	4481·873	·600	·400	·200	+13·38	2	50·0033	4341·050	·864	·634	·230	+15·87
3	63·5353	4476·462	....	.185	....	....	3	48·3771	4326·121	....	·939	......	....
2	63·1550	4472·329	·081	·676	·405	27·13	3	46·3742	4308·251	....	·081	......	....

Weighted mean..........	+18·79	
V_a		−5·42
V_d		·00
Curvature		− ·50
Radial velocity..........	+12·9	

β ORIONIS 501.

Slit ·0625.

1906. Dec. 19.
G. M. T. 16h 12m

Observed by / Measured by } J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	72·8040	4583·924	....	·018	......	....	1	62 6235	4466·587	....	·727	......	....
1½	69·9726	4549 663	....	·642	......	....	3	56·6706	4404·863	....	·927	......	....
1½	65·1830	4494·608	...	·738	......	....	1½	50 0022	4340·936	·000	·634	·366	+25·25
2½	64·0253	4481·818	·946	·400	·546	+36·52	3	48·3488	4325·866	....	·939	......	....
1½	63·4995	4476 076	....	·185	......	....	3	46·3462	4308·004	...	·081	......	....
1½	63·1436	4472·205	·333	·676	·657	44·01							

Weighted mean.........	+35·49	
Va.		−5·42
Vd......		·00
Curvature		− ·50
Radial velocity..........	+29·6	

β ORIONIS 502.

Slit ·0625.

1906. Dec. 19.
G. M. T. 16h 20m

Observed by / Measured by } J. S. PLASKETT.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W.L.	Normal W.L.	Displacement.	Velocity
2	72·8235	4584·165	....	·018	......	....	1	62·6467	4466·835	....	·727	......	....
1½	69·9810	4549·762	...	·642	...	....	3	56·6844	4405·005	....	·927	...	....
1½	65·2012	4494·811	....	·738	.....	....	¼	55·0210	4388·560	·480	·100	·380	25·95
2	64·0233	4481·796	·700	·400	·300	+20·07	1½	50·0089	4340·990	·910	·634	·276	+19·04
2	63·5206	4476·302	....	·185	....	....	3	48·3655	4326·016	..	·939	..	....
1½	63·1392	4472·157	·056	·676	·380	25·46	3	46·3639	4308·160	....	·081	......	....

Weighted mean.........	+21·59	
Va		−5·42
Vd		·00
Curvature.........		− ·50
Radial velocity.........	+15·7	

β ORIONIS 503.

Slit ·0625.

1906. Dec. 19.
G. M. T. 16^h 24^m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
3	72·8462	4584·445	....	·018	...	....	1	62·6597	4466·976	. .	·727	...	....
2	70·0030	4550·024	....	·642	.....	....	3	56·6994	4405·151	....	·927	.....	....
2	65·2219	4495·042	....	·738	......	....	¼	55·0276	4388·625	·445	·100	·345	23·56
2	64·0314	4481·885	·600	·400	·200	+13·38	1	49·9985	4340·902	·758	·634	·124	+8·55
1½	63·5377	4476·488	....	·185	.....	....	3	48·3708	4326·065	....	·939	.....	....
1½	63·1484	4472·257	·986	·676	·310	20·77	3	46·3699	4308·212	....	·081	....	....

Weighted Mean......	+15·23
V_a	−5·42
V_d	·00
Curvature...	− ·50
Radial velocity......	+ 9·3

β ORIONIS 504.

Slit ·0625.

1906. Dec. 19.
G. M. T. 16^h 31^m

Observed by } J. S. PLASKETT.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.
3	72·8352	4584·310	...	·018	.....	....	1	62·6457	4466·824	....	·727	.....	....
¼	72·8683	4584·718	·428	·018	·310	+20·21	3	56·6857	4405·014	....	·927	.....	....
2	69·9925	4549·899	...	·642	....	....	¼	55·0152	4388·503	·415	·100	·315	21·51
2	65·2057	4494·862	....	·738	... .	....	1	49·0085	4340·994	·898	·634	·264	+18·21
2	64·0387	4481·965	853	·400	·453	30·30	3	48·3686	4326·045	....	·939	....	....
1½	63·5210	4476·307	..	·185	....	....	1	46·3657	4308·176	....	·081	.....	....
1	63·1545	4472·323	·219	·676	·543	36·38							

Weighted Mean......	+27·91
V_a	−5·42
V_d	·00
Curvature...	− ·50
Radial velocity......	+22·0

β ORIONIS 505.

Slit ·075.

1906. Dec. 19.
G. M. T. 16ʰ 37ᵐ

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8287	4584 229	....	·018	.... .	....	1	62·6439	4466·806	. .	·727	......	....
2	69·9830	4549·786	....	·642	....	....	3	56·6794	4404·951	. .	·927	......	....
$1\frac{1}{2}$	65 2003	4494·802	....	·738	.....	. ...	$\frac{1}{4}$	55·0267	4388·617	·600	·100	·500	34·15
$1\frac{1}{2}$	64·0285	4481·853	·800	·400	·400	+ 26·76	1	49·9852	4340·779	·774	·634	·140	+ 9·66
1	63·5130	4476·219	....	·185	.....	....	3	48·3570	4325·940	....	·939	.....	....
$\frac{1}{2}$	63·1214	4471·964	·900	·676	·224	15·00	3	46·3560	4308·090	....	·081	....	....

Weighted Mean......	+ 20·26	
V_a		− 5·42
V_d		·00
Curvature .		− ·50
Radial velocity.....	+ 14·3	

β ORIONIS 506.

Slit ·075.

1906. Dec. 19.
G. M. T. 16ʰ 41ᵐ

Observed by J. S. Plaskett.
Measured by J. S. Plaskett.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity.	Weight.	Mean of Settings.	Computed Wave Length.	Corrected W. L.	Normal W. L.	Displacement.	Velocity
2	72·8542	4584·544	...	·018	......	....	$\frac{1}{2}$	62·6575	4466·952	....	·727	.....	....
$1\frac{1}{2}$	70·0029	4550·023	...	·642	... ..	....	3	56·7110	4405·267	....	·927	.. ..	....
2	65·2305	4495·138	.	·738	......	....	$\frac{1}{4}$	55·0170	4388·521	·185	·100	·085	5·80
2	64·0452	4482 036	·610	·400	·210	+ 14·04	1	50·0155	4341·058	·734	·634	·100	+ 6·90
1	63·5501	4476·624	....	·185	......	....	3	48·3927	4326·263	....	·939	......	....
1	63·1521	4472·298	·876	·676	·200	13·40	3	46·3888	4308·379	....	·081	......	....

Weighted Mean......	+ 11.72	
V_a		− 5·42
V_d		− ·04
Curvature .		− ·50
Radial velocity......	+ 5·8	

SUMMARY OF VELOCITIES.

Slit ·025		Slit ·0375		Slit ·05		Slit ·0625		Slit ·075	
Plate.	Velocity.	Plate.	Velocity.	Plate.	Velocity.	Plate.	Velocity.	Plate.	Velocity.
463	+13·8	466	+17·7	469	+11·7	500	+12·9	472	+23·6
464	14·5	467	15·7	470	17·5	501	29·6	473	12·9
465	15·2	468	17·6	471	15·0	502	15·7	474	13·0
494	23·3	496	16·7	498	18·7	503	9·3	505	14·3
495	15·9	497	19·2	499	21·7	504	22·0	506	5·8

	Slit ·025	Slit ·0375	Slit ·05	Slit ·0625	Slit ·075
Means	+ 16·5	+ 17·4	+ 16·9	+ 17·9	+ 13·9
r =	±1·17	± 0·38	± 1·14	± 2·42	± 1·91

General Mean +16·5 kms. per sec.

It will be noticed that there is not very good accordance in the velocity values of some of the plates; this may be accounted for partly by poor temperature control, partly by increased slit width and possible asymmetric position of the star image and partly by faulty guiding. The star is too bright for the best results in guiding by transmitted light, and it would be quite easy to obtain non uniform illumination of the collimator lens which might easily persist for the whole of an exposure. This ranged from 2^{mins} with slit $\cdot 075^{mm}$ to 6^{mins} with slit $\cdot 025^{mm}$ wide.

Any systematic displacement produced by any of these causes will not, however, affect the result obtained by discussing the residuals from each plate, and this is what was done in the first case. The residuals in kilometres per second from each line on a plate were grouped together for each slit width, five plates between 20 and 25 lines, and the probable error of the velocity obtained from the measurement from a single line was deduced.

Slit Width.	Probable Error.
$\cdot 025^{mm}$	$2\cdot 82^{kms}$ per second.
$\cdot 037^{mm}$	$3\cdot 19^{kms}$ "
$\cdot 050^{mm}$	$4\cdot 44^{kms}$ "
$\cdot 0625^{mm}$	$3\cdot 96^{kms}$ "
$\cdot 075^{mm}$	$4\cdot 63^{kms}$ "

The probable error, as the table indicates, increases gradually with the slit width although not nearly in the same proportion. If this diminished accuracy were permissible, the range of the instrument would be more than doubled. It is probable in spectra with sharper lines that the ratio of increase of probable error with slit width would be greater, and in spectra with more diffuse lines, less. The increase is undoubtedly due to the greater difficulty in setting accurately on the diffuse lines given when a wide slit is used. If the dispersion of the spectrograph were increased and the focus of the camera correspondingly shortened, this difficulty should be materially lessened, and as soon as a short focus camera lens is obtained for the new spectrograph, this investigation will be continued along the lines indicated, for the purpose of determining the maximum permissible slit width for reasonably accurate determinations, and for obtaining the relative efficiency of two spectrographs,—one with low dispersion and camera of long focus, the other with high dispersion and camera of short focus.

However, although not sufficient plates were measured to give a definite determination of the exact relation between slit width and accuracy, what has already been done seems to show that the slit width can probably be materially widened on early type stars without entailing much loss of accuracy.

The other three investigations mentioned above are given below as Appendices A, B, C, and complete the report of the astrophysical work done during the past year.

In conclusion, allow me again to express my deep sense of obligation for the many kindnesses you have shown and the help and encouragement you have always given me in my work.

I have the honour to be, sir,

Your obedient servant,

J. S. PLASKETT.

APPENDIX A.

(Reprinted from the *Astrophysical Journal,* Vol. XXV., No. 3.)

'THE CHARACTER OF THE STAR IMAGE IN SPECTROGRAPHIC WORK.

'BY J. S. PLASKETT.

'The object of this paper is to describe some experiments on the size and form of the star image given by the combination of objective and correcting-lens, with an investigation into the causes of the observed effects and suggestions for the improvement of existing conditions.

'The equipment of the Dominion Observatory, Ottawa, for radial-velocity work consists of a 15-inch telescope with a Brashear visual objective and photographic correcting-lens, and a spectroscope of the Universal type, also by Brashear. The objective for visual purposes is excellent, and the spectroscope is admirably adapted for general spectroscopic work, but, as the experience of others as well as myself has shown, is not suitable for the accurate determination of radial velocities. Its design as a universal spectroscope does not give sufficient stability, and, in exposures of any length, flexure will not only ruin the definition, but is liable to introduce systematic errors in the velocities obtained. Pending the construction of a spectrograph specially designed for the required purpose, an attempt was made to render the present instrument capable of giving accurate velocity values. The investigation and removal of the known sources of error led to the discovery of the aberrations to be presently described. A brief description of the steps leading thereto may be of interest.

'Trusses connecting the various parts of the instrument, where flexure could occur, with the supporting tubes were applied to such effect that an initial displacement of the spectral lines, equivalent to a velocity of 30 km per second, occasioned by a movement of telescope and spectroscope through two hours in right ascension, was reduced to 1½ km The prisms were firmly clamped in place, without inducing strains in the glass, by screws passing through the base of the prism-box and the minimum-deviation linkwork into the prism-cells. The slit-jaws, originally too thick on the edge, were reground, and the occulting diaphragms for star and spark light were removed from the slit-head and placed on an independent frame attached to the supporting tubes. The comparison apparatus was remodeled, the direction of the spark being made transverse to, instead of parallel with, the slit-jaws, and many other smaller details were carefully attended to.

'After all known sources of error in the spectroscope itself had been overcome, and after it had been placed in thorough adjustment, it was found that test spectra of the standard-velocity stars occasionally gave values differing by as much as 3 km per second from those obtained by other observers. As the probable error of the mean of the measured lines did not exceed four-tenths of a kilometre, and as all the other known causes of systematic error had been overcome, it seemed probable that this might be due to unsymmetrical distribution of the star light over the collimator and camera lenses. Evidently such unsymmetrical distribution can cause a displacement of the lines only when the camera is not in exact focus. The camera was always carefully focussed by a modification of Newall's method, which readily detected displacements of the sensitive surface from the focal plane of less than 0·05 mm in a focal length of 375 mm. But as the plates are supported only at the ends of the plate-holders, differences in the curvature of the glass may easily cause differences of

0·1 mm or more in the position of the center of the sensitive surface, where all measurements are made. In the case of a displacement of 0·1 mm from the focus, a distribution of the star light on the collimator objective so that its center of intensity is 5 mm to one side of the axis, is sufficient to cause a displacement of the spectral line $\frac{5}{375} \times \frac{1}{10} = \frac{1}{750}$ mm equivalent to a velocity of 1·8 km per second.

'An examination of the illumination pattern on the collimator lens, both visual and photographic showed how easily such or even greater displacements of the center of intensity could occur even with the utmost care in guiding. The illumination could never be made uniform, no matter how the relative positions of slit and correcting-lens were altered. The pattern was either a diametrical bar parallel to the slit of a width about one-third or one-fourth the aperture, or else such a bar with the addition of a peripheral ring; while a very slight movement of the slit-jaws to one side or other was sufficient to cause one side only of the lens to be illuminated, without causing any appreciable change in the appearance of the image in the guiding telescope, guiding being done by means of light coming through the slit. It is easy to see how the center of intensity of the star light could be displaced without the observer being aware of the fact, thus causing a displacement of the star lines unless the plate were in exact focus.

'The appearance of this pattern and its behaviour for change of slit position indicated spherical aberration of the condensing system. That aberrations of some nature were present was indicated not only by the long exposures required—upward of two hours for a star of the fourth photographic magnitude—but also by the large effective diameter of the image as shown by the wide opening, 0·25 mm, of the slit required to obtain uniform illumination.

'An examination of the correcting-lens showed that part of the difficulty might arise from the accidental inversion of the diverging element, which had been so placed in the cell that surfaces of unlike curvature were adjacent to each other. On inverting this concave element so that surfaces of like radius of curvature were in contact, the illumination pattern became more uniform, the required exposure time was diminished by 50 per cent. and no errors of a greater magnitude than should be expected with the dispersion employed, appeared in velocity determinations of standard stars. If the diameter of the object-glass, 15 inches, and the linear dispersion of the spectrograph, 18·6 tenth-meters per millimeter at $H\gamma$, be taken into account, the exposures required—less than an hour for stars of the fourth photographic magnitude—compare very favourably with those of other equipments.

'Notwithstanding the great improvement shown, photographic tests of the star focus for different temperatures indicated that the star spectrum was much wider than could reasonably be accounted for by atmospheric disturbance, and I was led to make thorough tests of the character and diameter of the image.

'To determine whether a narrower spectrum could be obtained by a change in adjustment, a plate was made for each of six settings of the correcting-lens, above and below its computed position, over a range of four inches. A simple device applied to one of the plate holders enabled ten successive star spectra to be made side by side on each of these plates, at different settings of the slit position in the neighborhood of the star focus; the sixty spectra forming a record of the diameter of the star image under varying conditions. To insure that the spectrum had not been widened by a drift of the star image along the slit, the spectroscope was turned in position angle until the slit-jaws were parallel to an hour circle. By opening the slit 0·2 mm, and by using a bright star, *Vega*, a fully exposed linear spectrum was obtained in eight or ten seconds, evidently with no chance of widening due to drift. The width of the narrowest part of the narrowest spectrum on each plate, presumably where the star was in focus on the slit, was measured, and these widths ranged from 0·085 to 0·115 mm. As the camera and collimator objectives are of the same focal length, and as one second of arc in the focus of the refractor is equivalent to 0·0275 mm, the diameter of the star image according to this test must be between 3″ and 4″·5. The diameter of the central diffraction disk as given by the formula $d = \frac{1 \cdot 2197\lambda}{r}$ is, for a 15-inch objective and $H\gamma$ light, about 0″·57, while the actual effective diameter as obtained from the width of star spectra is five to eight times as great.

'This enlargement of the diffraction image may be due to three causes: (1) aberrations in the spectroscope; (2) atmospheric disturbances; (3) aberrations in the system of objective and correcting-lens.

'1. *Aberrations in the spectroscope.*—It is a simple matter to determine whether the wide star spectra obtained are due to this cause, for by direct photography of the star image no aberrations in the spectroscope can affect the result. A series of star trails was therefore made on ordinary plates by the system of objective and correcting-lens. A small plate, held in guides in the slit-cap of the spectroscope, could be moved in these guides between exposures so as to make a number of trails on each plate. The collimator tube, carrying the plate with it, was moved by the rack and pinion about a quarter of a millimetre between each exposure, to insure having one of the trails within an eighth millimetre of the focus. A plate each was made of six stars ranging from the third to the sixth magnitude, and the width of the narrowest trail on each plate, corresponding to the position where the star was most nearly in focus, was measured. Although the conditions of seeing both for trails and spectra were above the average, about 3 in a scale of 5, the trails were not continuous, but broken and jagged, owing to atmospheric disturbances, and the measurements were made in two ways: first, of the width of narrow short parts of the trails where the seeing had been momentarily steady; and, second, of the average width of a longer strip of trail. In the first series of measurements the widths varied from 0·070 mm in the fainter stars to 0·110 mm in the brighter stars, while the average widths of longer strips were about 20 per cent. greater. Since the widths of spectra were practically the same, it is evident that the cause must be sought in the star image itself, and is not due to aberrations in the spectroscope.

'2. *Atmospheric disturbances.*—Newall, in his paper on the design of spectrographs* has introduced a very useful conception, that of tremor-disks, and he states that atmospheric disturbances enlarge the effective diameter of the star image. Such enlargement may be due either to bodily displacements of the image from its mean position or to the spreading-out of the central image into a more or less expanded disk. He considers that the actual effect, so far as getting light through the slit of a spectrograph is concerned, is the same as if the image consisted of a central core from 1″ to 2″ in diameter surrounded by a more or less diffuse and gradually diminishing portion, the whole diameter being in the neighborhood of 4″ or 5″. If we accept Newall's estimates as correct, and if we remember that in no case was a sufficiently long exposure given to allow the outlying parts of the tremor-disk to increase the width of spectrum or trail, then the diameter of the image given by the Ottawa objective and correcting-lens, even allowing the extreme limit assigned by Newall for atmospheric disturbances, is nearly twice as great as it should be.

'It is also a simple matter to test this conclusion experimentally. As the objective gives excellent visual definition, it may be safely assumed that the visual star image is of normal diameter. A measurement of the width of spectra and trails produced by the visual image, and a comparison with the widths given by objective and correcting-lens in photographic light, should at once decide whether the observed effect is due to atmospheric tremor. The correcting-lens was therefore removed, the spectroscope was adjusted for yellow light, and spectra were made similarly to the previous ones, though on Cramer Isochromatic plates, which have a pronounced band of sensitiveness almost

* Monthly Notices, 65, 808, 1905.

identical in wave-length with the turning-point of the color-curve of the objective. The widths of the spectra produced varied between 0·050 and 0·065 mm, about 2″, but as the seeing was very unsteady (about 1½ in scale of 5), these widths are doubtless about 25 per cent. greater than would be the case with good seeing. For the star trails the same make of plate was used, light of shorter wave-length than λ 5000 being absorbed by a yellow screen of plane glass placed in contact with the plate. Owing to the insensitiveness of the plate to light of wave-lengths between λ 5000 and λ 5400, and to longer waves than λ 5800, only the light which is effective in forming the visual image can act in producing the trails. As before, the width of the trails varied with the brightness of the stars, ranging from 0·025 mm in faint trails to 0·055 mm in stronger trails, or from 1″ to 2″, while the average width over a longer strip of trail was about 20 per cent. greater. Notwithstanding the bad seeing, both trails and spectra were much more sharply defined than those made with the correcting-lens in photographic light and of only half the width.

'These experiments conclusively prove that the abnormal width of spectra and trails in photographic light is not due to aberrations in the spectroscope nor to atmospheric disturbances, and clearly point to aberrations in the condensing system as the cause of the observed effects. A short summary of the experimental data will render this more evident. The theoretical diameter of the central disk, or rather of the first dark ring, for visual light λ 5600, is 0″·74, for photographic light, λ 4340, is 0″·57. The actual width of visual spectra and trails is from 1″ to 2″, or one and one-half to three times the theoretical diameter. The actual width of photographic spectra and trails is from 3″ to 4″·5, or five to eight times the theoretical diameter.

'Some further information regarding the size and character of the photographic image may be gained by considering its effective diameter under another aspect, that of the loss of light at the slit. Referring again to Newall's paper, and taking, as he does for an example, a tremor-disk of 5″ diameter with a core of 2″, we find that a slit 0·025 mm wide will transmit 31 per cent. of the incident star light; a slit 0·037 mm, 44 per cent.; a slit 0·05 mm, 58 per cent.; and so on. I am indebted to a suggestion by Professor Campbell for a method of testing this theoretical result experimentally. A series of star spectra were made at different slit-widths, and the resulting intensities were compared. As it is practically impossible to make a number of wide spectra of uniform intensity throughout their width, photometric measurements cannot be relied upon and recourse must be had to visual estimates. Such estimates can be made more accurately if the exposures are so regulated as to give spectra of equal intensity, and, moreover, within the limits of exposure time and intensity used here, errors due to the characteristics of the plate employed are to a great extent avoided. The spectrum of *a Lyrae*, the star used, is practically continuous except for the *H* series, and is therefore well suited for the estimation of intensities, while its brightness is such that only short exposures are required. Ten different slit-widths between 0·012 and 0·25 mm were used, and ten spectra, one through each slit-opening, were made side by side on the same plate. The exposures were so regulated as to render the resulting spectra as nearly equally intense as possible, and the final estimate is the mean from a number of plates and from spectra of different widths. To render the comparisons more direct, slit-widths will be represented by divisions, a single division corresponding to 0·025 mm, and the relative exposure times will be reduced to a unit of 100 with a slit-width of one division, 0·025 mm, or 0″·91, the normal width with the dispersion employed here.

'The following table shows that the exposure required is inversely proportional to the slit-width until this reaches 0·1 mm, leaving out of account widths less than a single division, where diffractional loss within the collimator plays an important part. It also shows that with normal slit-width less than 17 per cent. of the light incident on the slit is transmitted. In Newall's hypothetical case 31 per cent. would be transmitted. The experimental data given above, using Newall's method of calculation, indicate a tremor-disk 8″ or 10″ in diameter with a core of about 3″·5, and, as the previous experiments have shown, this is much larger than can be accounted for by atmospheric disturbances.

TABLE I.

LOSS OF LIGHT AT SLIT.

Slit-Widths.			Comparative Times for Equal Intensity	
Divs.	Mm	Secs.	Experimental.	Computed : $\tau=5''\gamma=2'$
½	0·012	0·45	300	....
1	·025	0·91	100	100
1½	·037	1·35	67	70
2	·050	1·82	50	54
3	·075	2·73	33	39
4	·100	3·64	28	34
5	·125	4·55	25	31
6	·150	5·45	21·7	31
8	·200	7·27	18·3	31
10	·250	9·07	16·7	31

'The above experiments point conclusively to aberrations in the system of objective and correcting-lens, when used with photographic light, as the cause of the observed effects, but they give no information concerning the nature of these aberrations beyond indicating in a general way, from the appearance of out-of-focus photographs of spectra and trails, that spherical aberration is present. It was decided therefore, to make quantitative tests to ascertain if possible the nature and magnitude of the aberrations and the best means of removing them.

'The most simple and accurate method of determining the zonal errors and axial astigmatism of a telescope objective is Hartmann's method* of extra-focal measurements. The principle of the method and the measurements and reductions necessary are extremely simple, while it gives accurate values with the expenditure of comparatively little time and without the use of any appliances except such as can be readily made by anyone. For the benefit of those who have not the above paper at hand, and in order to render the present article complete, the essential principles of the method will be briefly described.

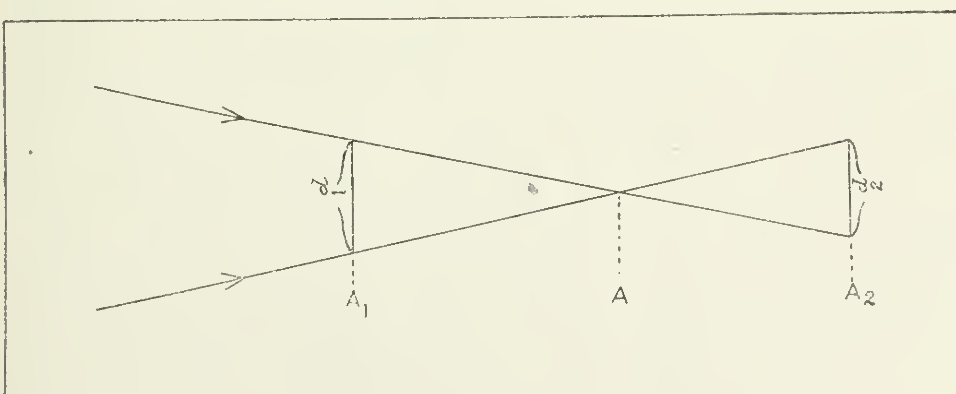


FIG. 1.—Determination of Focus.

'It depends upon the determination of the intersecting point of pencils of light coming from different parts of the objective. Suppose a diaphragm containing two

* Zeitschrift für Instrumentenkunde, 24, 1, 33, 97, 1904.

small openings, equidistant from the center and along a diameter, be placed over the objective. If the distance between the pencils of light coming from these openings be measured at two points, one within and one without the focus, the point of intersection of the pencils, and consequently the focus for the particular zone in question, can be at once obtained from similar triangles. For let d_1, Fig. 1, be the distance between the pencils at the scale-reading A_1 within the focus, d_2 the distance at the scale-reading A_2 beyond the focus. Evidently then the scale-reading for the focus A is $A_1+\left(\frac{d_1}{d_1+d_2}\right)(A_2-A_1)$. The distances d_1 and d_2 may be determined directly by micrometer measurements on the pencils from a star or distant artificial point-source, or by making exposures on photographic plates in the two positions and measuring the distances between the resulting images by a measuring microscope. The latter method is preferable and was used exclusively, except that the photographic determinations were checked by micrometer measures.

'A zone plate A, Fig. 2, similar to that described by Hartmann, was employed. The apertures, except the four inner ones, were each about 25 mm in diameter, and

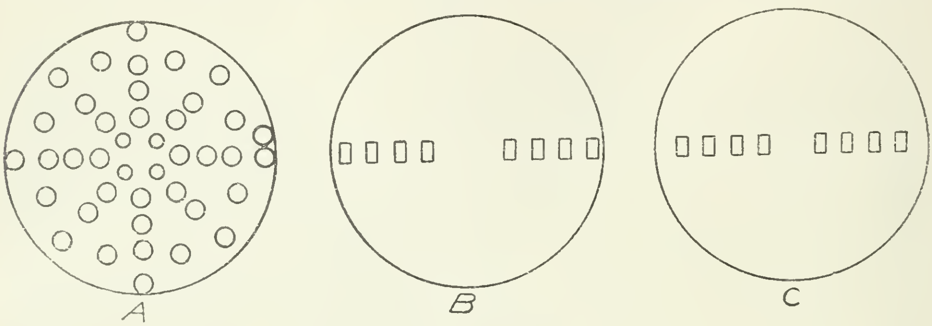


FIG. 2.—Zone Plates.

the radii of the nine zones were respectively 28, 47, 66, 85, 104, 123, 142, 160, and 178 mm. In order to determine the astigmatism along the axis, each pair of openings is duplicated by a second similar pair at right angles, so that the focus of each zone of the objective is determined for two elements perpendicular to each other. In the case of the zone of 142 mm radius the focus can be obtained for four elements 45° apart. Thus an exposure within the focus, and a second one without the focus, give data sufficient to determine the focus of each of nine zones of the objective in two directions perpendicular to each other. These two directions are distinguished from one another in the measurement by making an extra aperture in the zone plate, which, on being reproduced in the negatives, serves to identify the origin and direction of the angle ϕ.

'To determine the zonal errors of objective and correcting-lens, the zone plate was placed in position in front of the objective and a small photographic plate was placed in the guides in the slit-cap of the spectroscope. The spectroscope is supported on two parallel tubes carried by an adapter on the eye-end of the telescope, and can be readily moved up and down through a range of about 20 cm. Experience showed that the images were most sharply defined, and the best measurements could be obtained when the plates were between 6 and 10 cm from the focus. As the photographic focus was to be tested, an ordinary Seed 27 plate was first tried; but it was not found possible to make very accurate settings, as the pencils from the zone plate were spread out into radial spectra owing to the long range of wave-length (λ 5000 to the limit passed by the object-glass, say λ 3600) to which such a plate is sensitive. Several means of overcoming this difficulty were tried. As a yellow screen in front of an ordinary plate did not improve matters, the dispersion of the pencils must evidently be chiefly due to the light around $H\beta$. An ordinary lantern plate, which is sensitive from about λ 4600 down, was therefore next tried, and gave good images capable of accurate measurement; while if a yellow screen were used with such a plate the resultant images were again elongated, showing that the prolonged exposure entailed thereby had extended the action on the plate toward the red and reintroduced the first difficulty. A yellow or red star was used in preference to a white or blue, as limiting the action in the violet, shortening the effective range of spectrum, and thus giving images with less spectral dispersion and with no apparent elongation.

'Four sets of extra-focal plates were made which, on being measured, reduced, and averaged, gave the focal positions of the nine zones as tabulated below (Table II). All four measures are in substantial agreement, which of course is closer for the outer zones where the convergency of the pencils is greater. There the probable error of a single determination of the focus does not exceed 0·1 mm, while near the center it may be as great as 0·5 mm. It will be noticed that the focus for the edge of the objective and correcting-lens is upward of 2 mm longer than the focus near the center, and if astigmatism be taken into account also, the difference is greater than 2·5 mm. The values are plotted graphically in the curve (*A*) of Fig. 3, the vertical distances being magnified some six or seven times, the appended scale representing millimetres. The horizontal line is drawn in the position of focus 75·34 that gives the smallest circles of confusion, in this case 0·04 mm in diameter. The astigmatism will increase this to some extent, so that probably the diameter will be nearly 2″. Unless the slit is set exactly at this mean position, which is not likely, the diameter of the confusion disks will be still further increased, so that we may consider 2″ as a moderate estimate. It must be remembered, however, that in speaking of circles of confusion the conceptions of geometrical optics alone are being considered, and no account is taken of diffraction phenomena, which may have some effect on the geometrically calculated dimensions of the star disk resulting from aberrations of the magnitude here present. However, the experiments on the width of spectra and trails showed conclusively that the photographic image was about 2″ greater in diameter than the visual image, presumably unaffected by aberrations, and this agrees with the geometrical theory.

To determine where the aberrations arise it is necessary to accurately compare the performance of the objective used visually with the performance of the objective

TABLE II.

ZONAL FOCI OF 15-INCH OBJECTIVE.

Radius of Zone.	ϕ	Objective and Correcting-Lens Photographic.			Objective Alone Visual.		
		Focus.	Mean.	Astigmatism	Focus.	Mean.	Astigmatism.
28	45°	73·54	....	−0·20	106·43	....	−0·05
	135	73·94	73·74	+ ·20	106·54	106·48	+ ·06
47	0	74·19	....	+ ·08	108·35	....	+ ·42
	90	74·03	74·11	− ·08	107·51	107·93	− ·42
66	45	73·54	....	− ·30	106·67	....	− ·13
	135	74·14	73·84	+ ·30	106·93	106·80	+ ·13
85	0	74·15	....	+ ·11	106·42	....	+ ·26
	90	73·94	74·04	− ·10	105·91	106·16	− ·25
104	45	74·65	....	− ·23	106·15	....	− ·08
	135	75·11	74·88	+ ·23	106·31	106·23	+ ·08
123	0	75·68	....	+ ·22	106·20	....	+ ·09
	90	75·25	75·46	− ·21	106·02	106·11	− ·09
142	22·5	75·93	....	+ ·24	106·08	....	+ ·20
	67·5	75·32	....	− ·37	105·77	....	− ·11
	112·5	75·67	....	− ·02	105·82	....	− ·06
	157·5	75·83	75·69	+ ·14	105·83	105·88	− ·05
160	45	75·58	....	− ·15	105·91	....	+ ·04
	135	75 88	75·73	+ ·15	105·83	105·87	− ·04
178	0	76·11	....	+ ·21	105·93	....	− ·01
	90	75·69	75·90	− ·21	105·95	105·94	+ ·01
Mean focus......75·34						106·01	

and correcting-lens in the photographic part of the spectrum. Zonal tests were therefore made of the objective alone. For this purpose the wave-length of the light used must be limited to λ 5400–λ 5800, the range to which the eye is most sensitive, which is the most luminous in the spectrum, and which coincides with the turning-point of the color-curve of the objective. Fortunately, as the band of color-sensitiveness of Cramer Isochromatic plates almost exactly coincides with the same region, all that is necessary in order to obtain photographic test plates is to absorb the blue and violet light by a suitable screen, and thus confine the action to the visual part of the spectrum. A deep yellow screen with plane parallel surfaces was used in contact with the plate. Although the pencils from the zone plate are displaced slightly on passing through this screen, these displacements are proportional, and the only effect will be to lengthen the focus for all the zones by the same amount, about one-third the thickness of the screen, without in the least altering the relative positions of the pencils. An exposure of about a minute on *Capella,* through the screen, with the plate from 60 to 100 mm from the focus, gives a negative of good intensity in which the images of the pencils are quite round and free from any noticeable spectral elongation, thus allowing accurate measurement.

'Five sets of extra-focal exposures were made in the visual part of the spectrum, and the mean values resulting from the measurement and reduction of these plates are given in Table II and plotted graphically in curve F of Fig. 3. An examination of this curve shows that no point or focus is at a greater distance than 0·2 mm from the position of mean focus, shown by the horizontal line, except a small region near the center of the objective, which has a longer focus. The effect of this region on the performance of the objective must, however, be exceedingly small, owing to its small area, less than one-tenth of the objective, and to the weak convergency of the pencils proceeding from it. In fact if Hartmann's criterion T* as to the quality of an objective be computed from the above mean values, it is found to be 0·141. According to this classification an objective is moderately ("mässig") good when T is greater than 1·5, good when T is between 0·5 and 1·5, and exceedingly ("hervorragend") good when T is less than 0·5. In the ideal, absolutely zoneless objective T is 0.

'Evidently the objective when used visually is of the very first quality, and the aberrations appear only when it is used in conjunction with an auxiliary corrector for spectrographic work. Whether the aberrations there present are due to the correcting-lens, or to the objective when used in the photographic part of the spectrum, remains to be determined. For this purpose a further application of Hartmann's method was necessary to find the color-curves of the objective alone, and of the system of objective and correcting-lens for a number of zones. It was hoped that such observations would throw light on the cause of the aberrations and suggest a possible remedy. They would also serve as a check upon the zone-plate determinations, as, in this case, no spectral dispersion of the pencils could affect the accuracy of setting. To find such color-curves, the pencils of light coming from a zone plate fall on the spectroscope slit, and the distance between the resulting spectra taken with the slit within and beyond the focus gives a measure, calculated in the same way as before, of the focal position of any desired wave-length for any particular zone.

'It was decided to determine the color-curves of eight zones of 38, 57, 76, 95, 114, 133, 152, 171 mm radius; and, to prevent the spectra from merging into one another, two zone plates were required, one (B), Fig. 2, of the four zones of 57, 95, 133, and 171 mm radius, and the other (C), Fig. 2, of the remaining four. The central openings were each 20 mm square, and the outer 20 by 25 mm. The zone plates were so placed on the objective that the row of openings was parallel to an hour circle, and the spectroscope was turned in position angle until the slit was parallel to the openings, in order that irregularities in driving would not widen the spectra. To diminish the exposures as much as possible, bright stars, *Vega* and *Sirius,* were used and the

* Zeitschrift fur Instrumentenkunde, 24, 46, 1904.

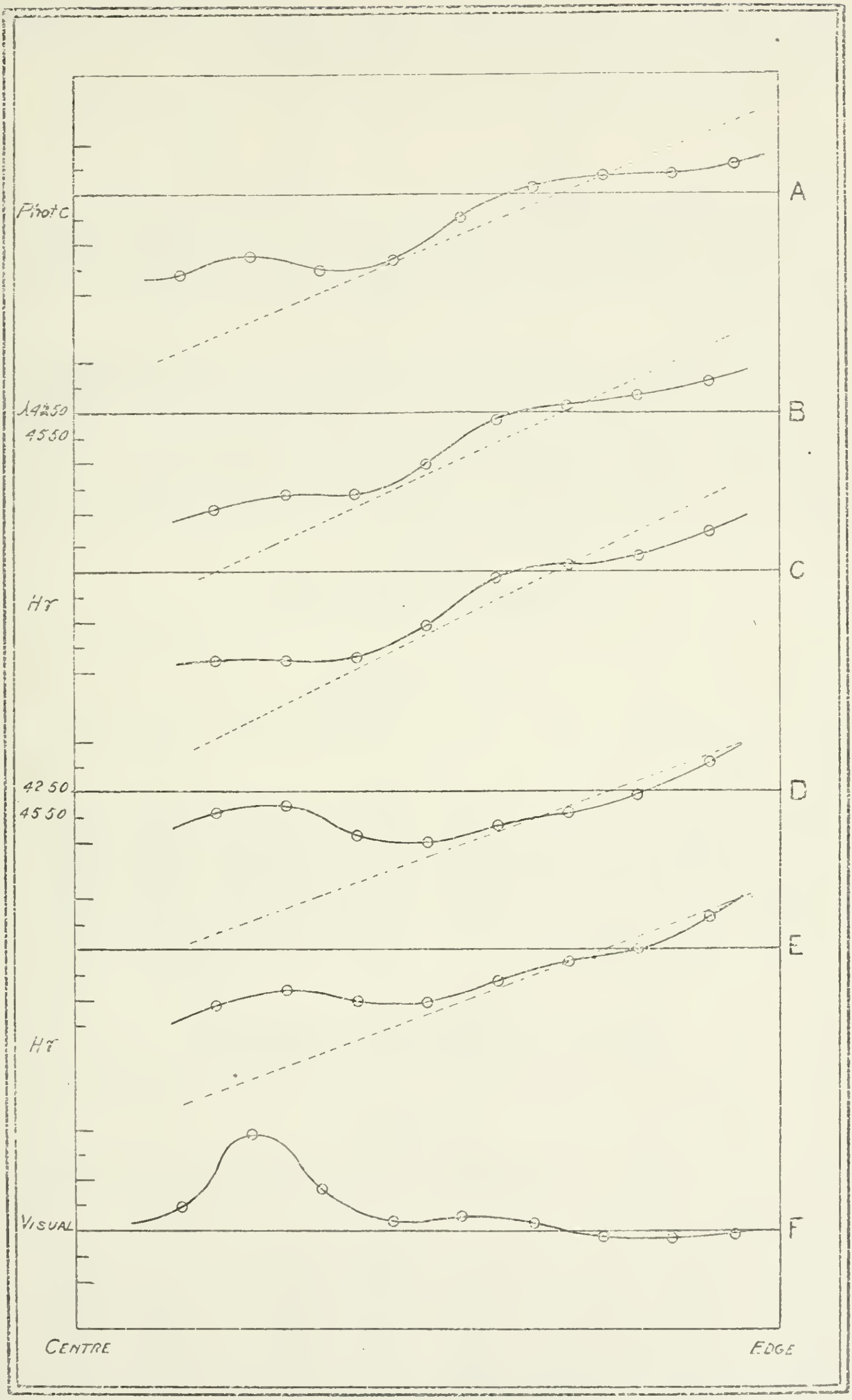


Fig. 3.—Zonal Differences of Focus.

slit was widely opened, as no inaccuracy would be thereby introduced in the distance between the spectra. The exposures were made on a night when the temperature was nearly stationary, and were arranged in the following order:

Plate 1;	Zone Plate (*B*)	Fig. 2; slit about	50 mm	within	the focus.
2;	(*C*)	"	50	"	"
3;	(*C*)	"	40	beyond	"
4;	(*B*)	"	40	"	"

'This procedure was followed to avoid as far as possible any relative displacement of the focal determinations of the two sets, due to slight changes of temperature of the objective. That no measurable displacement has occurred is shown by the continuity of the zonal curves of Fig. 3 drawn from the combination of the two separate determinations, and by their agreement with those made by the regular zone-plate method.

'Each of these plates contains eight spectra side by side, one from each light pencil transmitted by the zone plate, and the position of the focus for each zone and for any desired wave-length in the range on the plate can be determined in exactly the same way as before. The hydrogen lines, in the first type stars used, serve as datum marks for the identification of wave-lengths, and measurements were made at eleven positions between λ 3970 and λ 5030. The corresponding focal points, as calculated from these measurements, are given in Table III for eight zones of the

TABLE III.

COLOUR-CURVES OF OBJECTIVE ALONE.

Radius of Zone.	Wave-Lengths.										
	5030	$H\beta$ 4861	4680	4550	4440	$H\gamma$ 4340	4250	4175	$H\delta$ 4102	4035	$H\epsilon$ 3970
38	85·57	86·87	89·64	92·02	94·28	96·30	99·78	102·48	105·82	109·59	110·96
57	85 30	86·30	88·95	92·00	94·28	96·60	100·25	102·74	105·95	108·75	111·61
76	83·84	85·78	88·76	91·09	93·67	96·39	99·50	102·34	105·31	108·69	112·31
95	84·67	85·42	88·41	90·82	93·56	96·34	99·37	102·61	105·68	109·11	112·12
114	84·38	85·78	88·68	91·16	93·87	96·77	99·58	103·06	106·19	109·63	112·65
133	84·71	85·93	88·68	91·08	93·91	97·16	100·21	103·16	106·72	110·11	113·08
152	85·06	86·29	89·18	91·49	94·41	97·42	100·53	103·71	106·79	110·10	113·38
171	85·41	86·87	89·65	92·03	95·02	98·04	101·29	104·62	107·81	111·10	114·53

TABLE IV.

COLOUR-CURVES OF OBJECTIVE AND CORRECTING-LENS.

Radius of Zone.	Wave-Lengths.										
	5030	$H\beta$ 4861	4680	4550	4440	$H\gamma$ 4340	4250	4175	$H\delta$ 4102	4035	$H\epsilon$ 3970
38	55·12	54·75	53·11	51·18	50·65	50·92	50·92	51·17	51·36	51·68	51·91
57	53·38	53·89	52·55	51·98	51·24	51·04	50·90	50·91	50·95	51·30	51·82
76	54·51	53·67	52·54	51·60	51·19	51·14	51·16	51·11	51·20	51·46	51·26
95	55·57	54·37	53·16	52·46	51·95	51·70	51·60	51·74	51·96	52·30	52·66
114	55·45	54·82	53·62	53·12	52·79	52·59	52·65	52·79	53·03	53·24	53·31
133	55·94	55·10	53·88	53·33	52·06	52·89	52·93	53·05	53·31	53·60	53·73
152	55·84	55·13	54·05	53·54	53·26	53·07	53·25	53 38	53·49	53·62	53·64
171	56·05	55·39	54·38	53·90	53·60	53·53	53·56	53·97	54·15	54·27	54·34

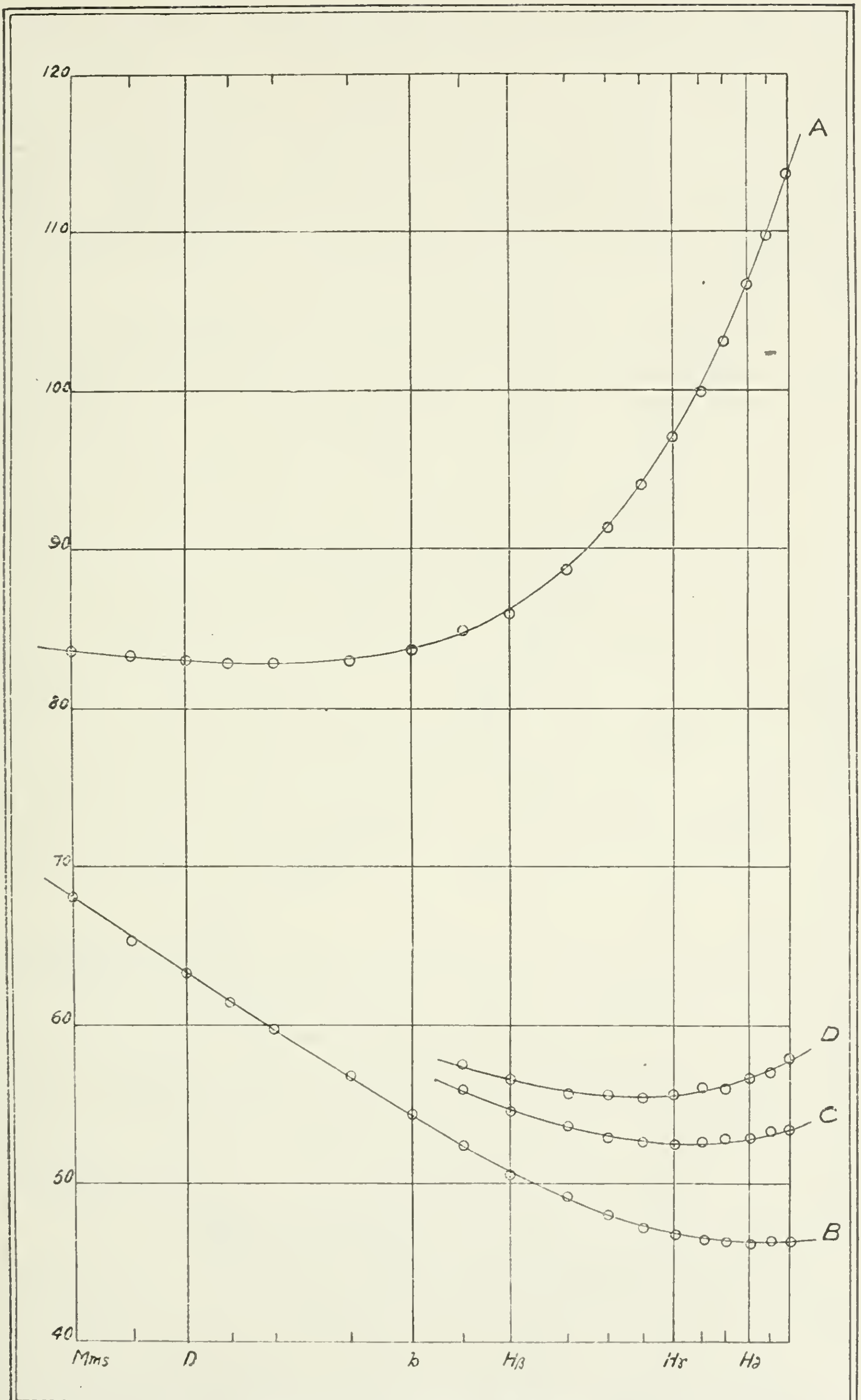


Fig. 4. Colour Curves for a Median Zone.

objective alone, and in Table IV for the same eight zones of the objective with correcting-lens, the latter being about 40 mm nearer the focus than its computed position.

'The reason for using the correcting-lens below its computed position at once appears on inspection of Fig. 4, which represents, in their correct relative positions, the color-curves of a median zone of 108 mm radius, determined in exactly the same way as above. Curve *A* (Fig. 4) is the color-curve of the visual objective between the limits λ 6250 and λ 3970, which shows that the minimum focus is at about λ 5600, exactly in its computed position. Curve *B* is the color-curve of the system of objective and correcting-lens between λ 6250 and λ 3970, which shows that the minimum focus is at about $H\delta$, instead of $H\gamma$, its computed position. When the correcting-lens is moved down, away from the objective, some 40 mm we get curve *C*, and at 70 mm, curve *D*. In curve *C* the minimum focus is nearly at $H\gamma$, and in *D* at λ 4460 Evidently the lowering of the correcting-lens some 40 mm effects considerable improvement in the color-correction without, as the earlier experiments showed, appreciably enlarging the image, and the lens has been used in this position almost from the first.

'Although all the data in regard to the complete color-curves are given in Tables III and IV, still the actual curves drawn from these figures show all the conditions at a glance, and are hence worth giving. To prevent too great a confusion of lines, the curves for four zones only (zone plate (*B*), Fig. 1), of 57, 95, 133, 171 mm radius, are shown here in Fig. 5, the upper curves being of objective alone, the lower of objective and corrector. These curves show at a glance that, in the photographic part of the spectrum, the focus for the edge of the objective is longer, than the focus for the center, that it has negative spherical aberration. This chromatic difference of spherical aberration is inherent in two-part objectives of the ordinary glasses, and the only remedy is to compensate for it by introducing the correct amount of positive aberration by the correcting-lens. However, the lower curves show that, instead of compensating for this chromatic difference, the correcting-lens has, on the contrary, increased it somewhat, and the focus for marginal rays is upward of 2 mm longer than the focus for central rays. This agrees almost exactly with the previous determination of the zonal foci of objective and corrector, and is good evidence of the substantial accuracy of the determinations. Before leaving these curves it may be pointed out that the crossing of the curve from the 57 mm zone over the others in passing from short to long waves is due to the longer focus of the central zones in the visual part and is further evidence in favour of the accuracy of the determinations.

'To obtain a still more striking comparison of the cause and magnitude of the aberrations present in the system, the color-curves can be presented in another form, that of zonal foci curves like *A* and *F*, Fig. 3, previously determined. We have the color-curves, or the positions of focus, of the whole photographic region for eight zones of the objective in Tables III and IV, and these can be readily plotted in the same way and on the same scale as *A* and *F*, Fig. 3. If such curves were plotted for every wave-length in these tables, they would show a striking agreement in form, but I have satisfied myself with representing the positions of the focus of eight zones for $H\gamma$, the wave-length for which the system was computed, and for the mean of λ 4250, 4340, 4440, and 4550, the range of spectrum used here in velocity determinations. *E*, Fig. 3, is the curve for $H\gamma$ of the objective alone; *C* is the curve for $H\gamma$ of objective and corrector. *D* is the curve for λ 4250 to λ 4550 of the objective alone; *B* is the curve for λ 4250 to λ 4550 of the objective and corrector.

'A comparison of curves *D* and *E* with *F* shows in a striking manner the chromatic differences of spherical aberration in the objective when used with photographic light. If we leave out of account or allow for the deviations in the central zones, we see that the focus of the outer is about 1·8 mm longer than the focus for the central zones, a figure that agrees almost exactly with the computed difference as furnished me by Professor Hastings. A comparison of curves *A*, *B*, and *C* with *D* and *E* shows that this difference, instead of being removed or diminished by the introduction of

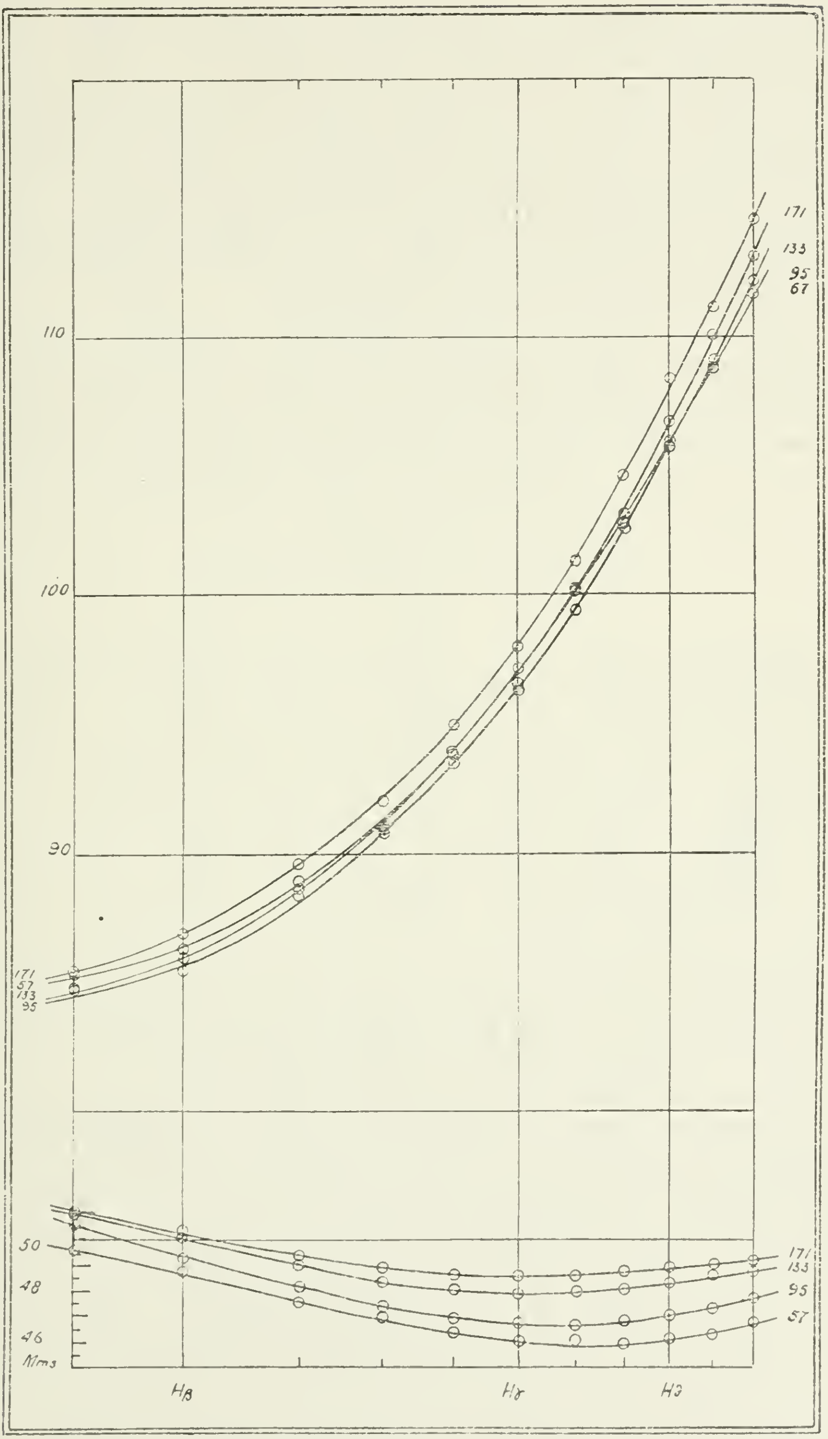


FIG. 5.—Colour-Curves of four Zones of Objective and of Objective with Corrector.

the correcting-lens has on the contrary been increased by about 0·6 mm, so that the difference in focus between outer and central zones is now about 2·5 mm, which, as before stated, will give a confusion disk nearly 2″ in diameter. I wish to point out, before leaving these curves, how the form of the curve is maintained throughout from *F* up to *A* except that the axis of the curve is inclined downward by the chromatic differences in the photographic region, and further tilted by the introduction of the correcting-lens. To show this I have dotted in the approximate positions of such axes in the curves *E* to *A* to correspond with the horizontal axis in F. It will be noticed that the irregularities in the visual curve are continued throughout, but in an intensified form, as is to be expected when it is considered that the objective was computed and figured for visual work, and its use in the photographic region with an auxiliary corrector was only a secondary consideration.

'I see no reason to doubt, however, if sufficient positive aberration were left in the correcting-lens to compensate for the negative aberration introduced by the chromatic differences, that the performance of the system could be much improved, although it is not likely, from the magnifying of the unavoidable zonal aberrations, that it would equal its visual quality. If the curve *A*, Fig. 3, representing the present condition of the system, could be tilted through the angle between the horizontal and dotted lines, by such a change in the correcting-lens, the resulting confusion disk would certainly have a diameter less than half its present magnitude, while the percentage of the incident star light transmitted by the slit would be considerably increased, probably doubled, with a proportionate diminution of the required exposure times for stellar spectra.

'Such an improvement would be well worth considerable effort, and I have been in communication with the Brashear Company and with Professor Hastings to that end. With their well-known willingness, I may even say anxiety, to produce the highest quality of optical work and to make any improvements that may be suggested to them, the Brashear Company are undertaking to make a new correcting-lens to computations by Professor Hastings, to whom I am very much indebted for criticisms and suggestions on the present paper. I may say that Professor Hastings finds a very marked agreement between his computed data of the objective, color-curves, and chromatic differences, and my observations. He explains the failure of the correcting-lens to compensate for the chromatic differences of focus, which it was computed to do, by the fact that this lens has to correct the errors of an objective of nearly fifty times the area, that the small departures of the wave-surfaces from a true sphere have grown enormously when these surfaces have contracted to one-fiftieth their original area, and that a very perfect correction by spherical surfaces can hardly be hoped for. He thinks, however, that considerable improvement can be effected, and I have no doubt myself that he and the Brashear Company can do much better than he says when they have quantitative values of the existing aberrations.

'The reason for publishing this paper in its present incomplete form, before the new correcting-lens is ready, is to bring before stellar spectroscopists the important matter of the size and character of the star image given by their telescopes. I have gone fully into the details of the investigation and explained the difficulties that arose with the means of overcoming them, in order to smooth the way for similar investigations into the character of the star image given by other systems of objective and correcting-lens. It seems to me extremely probable that, in the major part if not all of the telescopes employed in spectrographic work, aberrations of the same or a similar nature are present. If a correcting-lens computed to compensate for the chromatic difference fails in one case, it is possible, even probable, that it may fail in others. Another basis for this belief is a comparison of the relative exposure times required for different installations taking into account size of object-glass, slit-width, and dispersion of the spectrograph. I am well aware that such a comparison must necessarily be incomplete, and the results reached subject to an uncertainty, say, of

25 per cent., owing to the difficulty of comparing different installations under different conditions of seeing, etc. We have already seen how important a part is played by atmospheric disturbances in enlarging the star image so that the linear diameter of the image increases nearly in proportion with the focal length, and therefore approximately, as the ratio of aperture to focal length does not vary much in large instruments, with the diameter of the object-glass. Consequently, the effective value of increase of aperture is not proportional to the increase of area, but more nearly to the increase of diameter, which was accordingly used in the comparison. So far as regards the relative dispersion of different instruments, the exposure time was taken as directly proportional to the linear dispersion, presuming the same height of spectrum in each case. No account was taken of the difference in the loss due to absorption and reflection in the prism-train, although this may be quite important in some cases. 'The exposure time required was taken as inversely proportional to the slit-width, and this, as one of the experiments detailed above shows, is probably nearly in accordance with the facts. In the following Table V, data of the various equipments which are and have been used in radial velocity work, so far as they were available to the writer, appear, but these data are incomplete and may in some cases be in error, although probably not to a marked degree.

TABLE V.

COMPARISON OF EFFICIENCIES OF INSTALLATIONS.

Equipment.	Diameter of Objective, inches.	Ratio of Diameters.	Ratio of Areas.	Linear Dispersion, Tenth-Meters, per mm.	Slit-Width, mm.	Theoretical Exposure.	Actual Exposure Required.		
							β Ophiuchi.	γ Aquilae.	α Boötis.
Ottawa	15	1	1	18·6	0·025	1	50m	60m	6m
Yerkes	40	2·67	7·1	10·8	·038	0·42	75	115	15
Lick	36	2·4	5·76	12·5	·025	0·62	25 ?	25 ?	4 ?
Lowell	24	1·6	2·56	11·4	·025	1·02	120	120	20 ?
Newall	25	1·67	2·78	14·6	·025	0·76	70	75	15
Bonn	12	0·8	0 64	15·2	·020	1·91	75	75	15
Pulkowa	30	2·0	4·0	13·0	·020	0·89	65 ?	65	15
Lord	12½	0·83	0·69	18·6	.025	1·20	60 ?	60 ?	4

'The above comparison shows that the Lick, Bonn, and Lord equipments *in practice* approach more nearly the theoretical efficiency than the Ottawa, but the Yerkes, Lowell, Newall, and Pulkowa depart farther from it.

'There seems therefore reasonable ground for believing that considerable improvement in the efficiency, and considerable increase in the range of the majority of spectrographic equipments can be attained by looking into the character of the star image given by the condensing system. Although the exact effect of atmospheric disturbances on the effective diameter of the star image is difficult of determination, I feel satisfied, if I can obtain a correcting-lens that will give a star image reasonably free from aberration, that the exposure times required here can be very materially reduced, I hope by 50 per cent., and I see no reason why a similar or even greater improvement could not be effected in some of the other equipments.

'I acknowledge with pleasure my indebtedness to Dr. W. F. King, the Director of the Observatory, for help and encouragement in the prosecution of the work, and to Mr. W. E. Harper for making duplicate measures for comparison purposes on some of the test plates.

'DOMINION OBSERVATORY, OTTAWA.
'January, 1907.'

APPENDIX B.

(Reprinted from the Journal of the Royal Astronomical Society of Canada, Vol. 1, No. 1.)

'THE SPECTRUM OF MIRA CETI.

'BY J. S. PLASKETT.

'The spectrum of *o Ceti* has been photographed at the Dominion Observatory 18 times on 11 nights during the months of December, 1906, and January, 1907. The number of observing nights during these two months has been very limited, the weather having been unusually cloudy, and no more spectra of this interesting variable could be obtained.

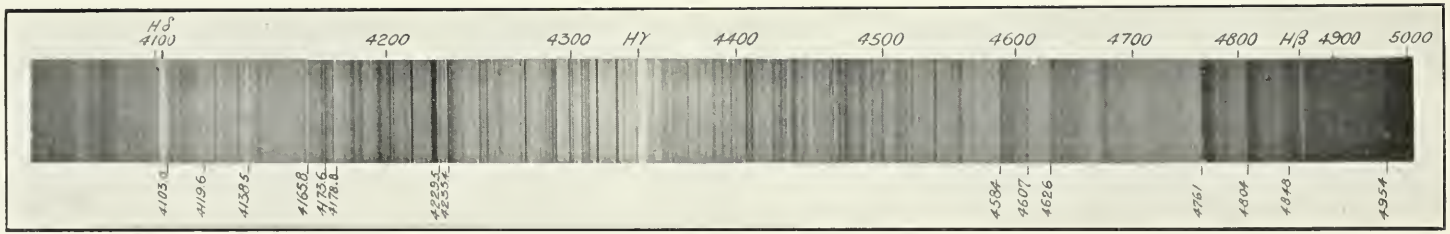
'The spectrograph at present in use is an adapted Brashear Universal Spectroscope, having collimator and camera lenses of 1¼ inches aperture and 15 inches focus, and a train of three dense flint prisms, index for $H\gamma$ about 1·64, giving a linear dispersion at $H\gamma$ of 18·6 tenth-meters per millimeter, with a resolving power of 40,000. A spectrum about 55 mms. long is obtained, of which, however, owing to curvature of field of the triplet camera lens, only about 15 mms. in the centre is in the best focus. The balance of the spectrum becomes more and more diffuse towards the ends of its range, which extends between λ 3950 and λ 5100. The extreme limits measured for radial velocities lie between λ 4200 and λ 4584, but it is possible to obtain fairly accurate values of the wave lengths, within one tenth of a tenth-metre, between $H\beta$ and $H\delta$.

'The spectrum of *Mira,* observed at this maximum, differs in some essential particulars from previously recorded observations.

'The star has been much brighter than for several previous maxima and it is natural enough, if we consider its variability to be due to changes in its internal condition, to expect a change in its spectrum. These changes appear both in the absorption and the emission spectrum, and will be treated in greater detail later on.

'Probably the most striking change is in the character of $H\beta$, which had been previously recorded as either dark, or as only faintly bright. Sidgreaves (*M.N.* LVIII., p. 344) did not consider he had certainly seen Hβ bright. Miss. Maury (H.C.O. *Annals* XXVIII., p. 45) saw it bright on some Harvard plates. Campbell (*Astrophysical Journal* IX., p. 31) could not see it visually, while Stebbins, (*Ibid* XVIII., p. 341) in his exhaustive paper, was successful in recording both it and $H\epsilon$ on some plates, but with much less relative intensity than at this maximum. In every spectrum made here, even those with only two minutes exposure, $H\beta$ is distinctly and certainly bright, and there is not the slightest doubt of its emissive character. No trace whatever has been seen of $H\epsilon$ on any of our plates and it is apparently not present. It also had never been seen bright until Stebbins recorded it.

'A number of comparative exposures from one minute to twenty minutes were made to determine, among other things, the relative intensity of the emission and absorption spectra. As an estimate from these plates,—no attempt was made to accurately determine intensities,—I would say that the bright $H\beta$ had an intensity about 15 times that of the continuous spectrum in that region, $H\gamma$ about 25 times and $H\delta$ at least 50 times. These estimates apply to the plates of January 23 and 26, when the star was considerably past maximum. In December no comparative tests were made, but the ratio would not be very much different, so far as can be judged, from the over-exposed emission lines.



Spectrum of O Ceti (Mira).

Photographed by J. S. Plaskett at the Dominion Observatory, Ottawa, 1906, Dec. 18th, 14 h. 32 m. G.M.T.
Length, 4; width, 70 times the original.

'Before discussing the character of the spectrum it will be preferable to give the record of observations and the measures of the wave-lengths of the lines and bands obtained from the most suitably exposed spectrum, No. 486. Although 486, 515 and 521 are the best of the plates, the first eight are all measurable, and of these 486 and 515 have been reduced for the wave lengths of the absorption lines and bands, and for the determination of the radial velocity. All the plates, with the exception of 575 to 578, in which the camera was accidentally not in good focus, have been measured for the velocities due to the $H\gamma$ emission, and they show, as will be seen, fair agreement with one another and with Professor Campbell's previously determined values. The velocities obtained from the absorption part of the spectrum in the two plates measured agreed so closely with one another, and at the same time were nearly the same as Professor Campbell's and Mr. Stebbins' values, that it was not thought necessary to measure more plates.

RECORD OF OBSERVATIONS.

Plate No.	Date.	G.M.T.	Exp.	Prism temp	Seeing.	Observer.	Remarks.
452	Dec. 11	14 29	18 m.	− 3·5	Good	H	Absorption spectrum underexposed.
486	" 18	14 32	19 m.	− 1·6	"	H	Good spectrum.
493	" 19	14 50	20 m.	− 7·4	Fair	P	Underexposed.
515	" 27	15 55	30 m.	+ 2·1	Poor	P	Fair spectrum.
521	Jan. 9	13 45	30 m.	− 12·8	Fair	P	Good spectrum.
534	" 15	14 35	40 m.	− 12·8	Poor	H	Underexposed.
555	" 18	14 30	60 m.	− 8·0	Poor	P	"
563	" 21	13 55	20 m.	− 12·3	Good	P	"
569	" 22	15 16	05 m.	− 8·9	Fair	H	For emission lines only.
575	" 23	13 43	20 m.	− 18·8	"	P	For emission lines.
576	" 23	14 07	10 m.	− 18·8	"	P	" "
577	" 23	14 17	05 m.	− 18·8	"	P	" "
578	" 23	14 23	02 m.	− 18·8	"	P	" "
579	" 26	12 15	20 m.	− 10·0	Good	P	" "
580	" 26	12 32	10 m.	− 10·0	"	P	" "
581	" 26	12 41	05 m.	− 9·9	"	P	" "
582	" 26	12 46	01 m.	− 9·8	"	P	" "
583	" 26	12 50	02 m.	− 9·8	"	P	" "

'In the above measures, the wave lengths of the star lines are determined in the usual way, from the linear positions of the star and comparison lines on the plate, by Hartmann's interpolation formula. The displacement of the lines in tenth-metres due to the motion of the star is known, when the velocity is known from the formula

$$\delta\,\lambda = \frac{v\,\lambda}{299{,}860}$$

'The velocity is obtained from the mean of the velocities due to 25 lines near the middle of the plate, which had been identified as far as possible with known terrestrial or solar wave lengths. This velocity, on being transferred back into displacement by the above formula, gives the correction to be applied to the measured wave-lengths of the absorption lines, emission lines, and bands at the ends of the plate, to reduce them to normal wave lengths.

o CETI, No. 486.

1906. Dec. 18.
G. M. T., $14^h\ 32^m$

Observed by W. E. Harper.
Measured by J. S. Plaskett.

Measured Wave Length.	Normal Wave Length.	Displacement.	Velocity.	Remarks.
4955·520	4·04			Red Edge of Bright Band
4862·877	1·527	1·350	[+82·75]	H β Emission
4848·948	7·55			R. Edge of Band
4806·639	5·24			Line near edge of band
4805·866	4·46			R. Edge of Band
4763·309	1·91			Mn line near edge of band
4762·766	1·36			R. Edge of Band
4657·795	6·39			Ti Cr
4627·889	6·49			Cr Mn Line at R. Edge of Band
4608·688	7·28			Sr 7·51 Line at V. Edge of Band
4595·652	4·27			V 4·30
4585·917	4·53			Fe Line at R. Edge of Band
4581·841	0·46			V Cr 0·59, 0·23
4578·749	7·356	1·393	+91·10	V
4537·372	5·965	1·407	93·00	Ti Cr
4528·920	7·490	1·430	94·66	Ti
4524·335	2·974	1·361	90·23	Ti
4519·698	8·198	1·500	99·45	Ti
4472·804				Ti
4463·437				Fe Mn V
4454·705	3·505	1·200	80·76	Ti Mn
4436·630	5·439	1·191	80·49	Ca Ca
4428·730	7·420	1·310	88·68	Ti Fe
4406·211	4·951	1·260	85·80	Fe
4402·065	0·738	1·327	90·37	V
4396·746	5·286	1·460	99·42	Ti V
4386·213	4·873	1·340	91·65	V
4385·076	3·720	1·356	92·88	Fe
4380·616	9·396	1·220	+83·57	V
4369·560	8·26			Ti Fe
4354·312	3·038	1·274	87·78	Fe V
4345·977	4·597	1·380	95·22	Ti Cr
4341·734	0·634	1·100	[75·90]	Hγ Emission Line
4334·204	2·988	1·216	84·02	V
4331·409	0·189	1·220	84·30	V
4316·224	5·018			Ti Fe
4307·438	6·078	1·360	94·65	Ti
4297·334	5·914	1·420	96·84	Ti Cr
4292·800	1·50			Ti Fe
4276·252	4·922	1·330	93·10	Cr Ti
4259·747	8·477	1·270	89·28	Fe
4248·296	6·996	1·300	91·78	Y
4234·618	3·36			Fe Emission
4231·277	0·00			Fe 9·93
4230·768	9·51			Fe Emission ?
4228·131	6·904	1·227	86·99	Ca
4208·190	6·862	1·328	94·68	Fe
4180·090	8·84			V Ce Emission ?
4180·937	9·68			V 9·54
4179·069	7·82			Fe 7·70
4175·473	4·22			Fe 4·09
4174·826	3·58			Ti Fe Emission ?
4167·096	5·84			Ce Cr Fe Emission
4139·778	8·53			V Ce Mo Emission
4135·897	4·49			Fe V 4·49, 4·59
4126·867	9·56			Fe V Ce Mo Emission ?
4104·185	2·95			Mn Emission ?
4103·030	2·000	1·030	[+75·29]	Hδ Emission

$\epsilon = \pm 5·2$
$\epsilon_0 = \pm 1·0$

Mean of Absorption Lines	+90·43	
V_a		−24·20
V_d		− 0·09
Curvature correction		− 0·50
Radial velocity =		+65·6

o CETI, No. 515.

1906, Dec. 27.
G.M.T., 15^h 55^m.

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Measured Wave Length.	Normal Wave Length.	Displacement.	Velocity.	Remarks.
4572·705	1·275	1·430	+93·66	Mg
4550·222	8·938	1·284	85·27	Ti
4546·234	4·845	1·389	91·70	Cr Ti
4541·976	0·776	1·200	79·32	Cr
4537·385	5·965	1·420	94·00	Ti Cr
4528·780	7·490	1·290	85·40	Ti
4524·360	2·974	1·386	91·96	Ti
4497·975	6·57			Ti Mn Cr
4490·902	9·60			Cr
4463·517	2·21			Fe Mn
4461·557	0·20			V Mn
4459·016	7·656	1·360	91·39	Ti V Mn
4454·885	3·505	1·380	92·87	Ti Mn
4439·396	8·006	1·390	93·82	V
4428·780	7·420	1·360	92·07	Ti Fe
4427·351	6·201	1·350	91·39	Ti
4406·331	4·951	1·380	93·82	Fe
4402·076	0·738	1·338	91·18	V
4396·696	5·286	1·410	95·88	Ti V
4389·806	9·396	1·410	96·58	V
4369·560	8·071	1·489	102·06	Fe
4354·348	3·038	1·310	90·00	Fe V
4353·316	2·006	1·310	90·00	Cr Mg
4341·784	0·634	1·150	[79·35]	Hγ Emission
4334·308	2·988	1·320	91·10	V
4320·247	8·817	1·430	99·24	Ca Mn
4307·558	6·078	1·480	103·00	Ti
4302·203	0·945	1·258	87·68	Ti
4297·244	5·914	1·330	92·83	Cr Ti
4290·617	9·237	1·380	+96·32	Ti

	Mean of Absorption Lines	+ 92·48
$\epsilon = \pm 4·7$	V_a	−26·45
$\epsilon_o = \pm 0·9$	V_d	− 0·22
	Curvature correction	− 0·50
	Radial velocity =	+65·3

'In the tables above, of plates 486 and 515, the first column contains the wave lengths computed from the linear measures by Hartmann's formula. The second column contains the normal wave-lengths determined, in the cases where there are no entries in the two succeeding columns, by the process outlined above, and in the other cases where the lines have been identified, by taking the corresponding wave-lengths from Rowland's table.

'These identifications have been made as consistently as possible, using only those elements which it was considered probable from the similarity of *o Ceti* to third type stars, would be present in the star. The third column contains the displacement of the line in tenth-metres from its normal position due to motion, and is obtained by subtraction of the second column from the first. The fourth column contains the velocity corresponding to this displacement, obtained by multiplying by 299,860/λ.

'Let us consider in the first place the radial velocity of *o Ceti* as determined from the displacements of the absorption and emission lines. The mean velocity from the absorption lines in No. 486 is + 90·43 kms. per second, which, on applying the correction for the orbital and diurnal movement of the earth, and for the curvature of the spectral lines, reduces to 65·61 kms. per sec., recession, compared with the sun.

For plate 515 the velocity is + 65·3 kms., in good agreement with the first. Professor Campbell,* from his determinations in 1897 and 1898, obtained a mean velocity of + 62·3 kms., and Stebbins in 1902, of 66 kms. This shows that the motion of the star is constant, as the variation between the Lick and Ottawa determinations can readily be accounted for by the uncertainty in the identification of the lines, and in the intensity to be assigned to them in the blends, in a star so different from the sun in its absorption. Campbell's value of the velocity is probably more nearly the true one on account of the greater dispersion and resolving power of the Mills spectrograph, which admits of the resolution of lines much closer together than is possible with the Ottawa instrument.

'The errors in identification and blending are plainly shown by the very high mean error $\epsilon = \pm 5\cdot2$ of the determination from a single line. In the case of stars like *β Geminorum* and *α Boötis*, where their similarity to the Sun allows of satisfactory identifications and blends, the mean error is only one-third of the above, while the mean error of setting on the lines of *o Ceti* which are of good quality for measurement, is not materially greater than with solar stars. It is evident, therefore, from the satisfactory agreement of the velocities obtained at two epochs nine years apart, that the star's velocity, so far as it is determined from displacements of the absorption lines, is constant, and, as Professor Campbell has already said, its variability is probably not dependent upon or connected with any orbital motion.

A comparison of the displacements of the bright hydrogen lines on the two plates already measured, and their corresponding velocities, with the mean velocity from the absorption lines, shows that the former is about 15 kms. smaller, that, if the displacement could be explained by velocity changes only, the emissive layer is lagging behind the absorptive layer at the rate of 15 kms. per sec. It is of course more likely that the difference is due to some unknown condition in the atmosphere of the star which may displace the spectral lines. To obtain all the information possible in regard to the character and displacement of the hydrogen emission lines, a number of plates were made with varying exposure, from 1 minute to 20 minutes, and these were carefully compared with one another and with the previously exposed more intense plates to determine the form of the emission lines. No trace could be found of Campbell's triple formation in any of the plates, although the earlier ones, when the star was near maximum, were not suitably exposed to exhibit such an effect. The lines were, however, in the majority of the plates, unsymmetrically broadened with respect to the actual centre of intensity determined from the tips of the emission lines. These tips were nearer to the violet side of the bands, showing that the radiation was not symmetrical, and this asymmetry became more evident, the more intense became the line. This is indicated in two ways in the table of the velocities due to the bright hydrogen lines, first by the actual measure of the positions of the red edge of the tips, and of the violet edge of the bright $H\gamma$ lines, and second, by the smaller velocities given by the short exposure, less intense plates, as compared with the plates exposed for the absorption spectrum, in which the emission lines were much over-exposed.

* *Astrophysical Journal,* IX., p. 31.

RADIAL VELOCITIES, *o CETI.*

From $H\gamma$ Emission line.—Reduced to the Sun.

Number of Plate.	Exposure Time.	Observer.	Red Edge of $H\gamma$ to Tips Revs.	Tips of $H\gamma$ to Violet Edge Revs.	Rad. Vel.	Remarks.
452	18 min.	H	·086	·073	+48·5	
486	19 "	H	·099	·083	51·1	
493	20 "	P	·088	·076	46·7	
515	30 "	P	·083	·056	52·2	
521	30 "	P	·091	·078	48·8	
534	40 "	H	·075	·070	51·1	
555	60 "	P	·102	·046	37·9	Abnormal? (Poor night and change of temp.)
563	20 "	P	·067	.068	43·0	
569	05 "	H	....	....	44·0	
579	20 "	P	·057	·055	45·4	
580	10 "	P	·057	·038	46·8	
581	05 "	P	·046	·047	44·3	
582	02 "	P	....	....	45·7	
583	01 "	P	....	....	40·1	

Mean of 14 plates = + 46·1
Mean of plates exposed for absorption spectrum = + 48·0
" " emission spectrum only = + 44·2

'These measures show a fair agreement among themselves, but this accordance is considerably increased when they are divided into two sets—of the strongly and moderately exposed plates,—and when plate No. 555 is omitted. It is abnormal in the marked asymmetry of the bright line, as shown by the measure in columns 4 and 5, and its low velocity may be due to the long exposure on a poor night, where an instrumental displacement might have occurred through change of temperature.

'The mean of the first six. exposed for the absorption spectrum, is 49·9, and the mean of the last seven, exposed for the emission spectrum, is 44·2. This difference may be due to two causes, either an actual change in the position of the centre of intensity of the bright $H\gamma$, or an apparent change due to an unsymmetrical broadening of the line on the plate, caused by the over exposure of a bright line whose curve of intensity is not similar on each side of the centre. In the case of the first six plates, in which the emission lines are over exposed, the velocity obtained is greater, indicating that the setting of the microscope wire had been further to the red than in the case of the last seven. Mr. Harper, to whom I am indebted for the measurement of these plates, tells me that in each case he set the wire as nearly as possible on the centre of the broad black line and no attention was paid to the tips. This would indicate that the emission line was slightly asymmetric towards the red, thus shifting the setting towards the red with increased exposure, and the displacement is not likely due to an actual change in the position of $H\gamma$ itself.

'There is a remarkable agreement between the mean velocity 44·2 kms. obtained from the last 7 plates, and the mean velocity 44·4 kms. found by Prof. Campbell from 6 plates made by him in November 1898, when, as he says, the lines appeared nearly monochromatic, with a faint broadening or companion to the red side, practically of the same character as observed here. This would tend to show that the conditions in the star under which the bright $H\gamma$ lines are produced, tend to repeat themselves at different maxima, so far, at any rate, as the displacement is concerned, although the relative intensity of the different members of the H series is widely different.

'No trace can be found, however, in these spectra of the bright *Fe* lines at 4308·081 and 4376·107, recorded by Profs. Campbell and Stebbins, but there are no fewer than 8 lines between $H\delta$ and λ 4235 which have every appearance of emission lines. They stand out as isolated narrow bright lines in a fairly uniform strip of absorption spectrum, with an intensity at least twice as great as the back ground of spectrum in which they lie, and are even shown prominently in the widened reproduction of plate 486. It seems hardly possible that they can be narrow strips of continuous spectrum left unabsorbed, as their width is generally less than half a tenth-metre. It may be said on the contrary, however, that they have not been identified with any one element, and that the nearest identifications, are of elements which have the most pronounced lines in the absorption spectrum. There is an exception to this statement in the case of four of the lines which fall reasonably close to four lines in the spectrum of Cerium.

'The wave-lengths, and the nearest metallic lines are as follows:—

BRIGHT LINES IN THE SPECTRUM OF *o* CETI.

NORMAL W.-L.	NEAREST METALLIC LINES.			
* 4233·36	4233·76 Fe,	4233·33 Mn Fe		
4229·51	4229·61 Fe,	4229·87 V		
4178·84	4178·54 V,	4179·45 Ce		
4173·58	4173·71 Ti,	4174·00 Fe,	4173·39 Fe	
* 4165·84	4165·78 Ce,	4165·71 Cr,	4165·60 Fe	
* 4138·53	4138·27 V,	4138·51 Ce	4138·70 Mo	
4119·56	4119·62 V,	4119·99 Ce,	4119·77 Mo	4119·55 Fe
4102·95	4103·14 Mn,			

'The three lines marked with a star (*), are those which appear the most sharply defined and separated from the absorption spectrum, and which seem to be almost certainly emissive in character.

'The normal wave-lengths were obtained from the measured wave-lengths by subtracting the displacement equivalent to the velocity of the absorption lines. If the mean value of the velocity due to the bright *H* lines were applied to the normal wave lengths above given, they would be increased by 0·25 tenth-metres. Owing to the distance from the centre of the spectrum and the consequent poor focus, the wave-lengths above given may be uncertain to the extent of one tenth of a tenth-metre, possibly more, although the identifications of the absorption lines measured in that region agree to the same limit with the values in Rowland's table. It seems, therefore, impossible to certainly identify any of these lines with the metallic emission lines, though their appearance and their isolated positions in the general absorption in that region scarcely admit of any other interpretation of their character than the emissive one. A further evidence in this regard is their appearance in some of the other early spectra, in which the exposure was insufficient to show any but the faintest trace of absorption spectrum in the given region. Stebbins, in his paper found only one of the above lines as bright, λ 4233·36, but did not attempt any identification. He also finds λ 4178·84 as apparently bright, but considers it to be only a bright place between two absorption lines. He gives no record of the other lines registered as bright here, and evidently they were not visible in his spectra. Professor Campbell, in his observations says there is good reason to believe in a bright line at λ 4102·8, evidently the same as the one observed here at λ 4102·95. He also mentions one or two more as probably present on the violet side of $H\delta$, but no such lines can be seen in our spectra.

'The absorption spectrum of *o Ceti* is of the banded type, Secchi's third, Miss Maury's XX., and has scarcely any recognizable similarity to the solar type. It is considerably different from *a Orionis* and even further advanced than *Herculis*. Its character is well shown by the identifications in the tables of measures of plates 486 and 515. The only absorbing elements present in the strong and best defined lines, those which were measured, are Ti, V, Fe, Mn, Cr, Ca also is present, and a stray *Mg* line appears in No. 515, which is undoubtedly the same line seen as distinctly bright by Stebbins. The first specified are those which are most strongly affected in the spectra of sun spots, and which, as Professor Hale and Mr. Adams have shown,*

* *Contributions of the Solar Observatory*, Nos. 8 and 18

are much intensified in the spectrum of Arcturus and still more so in *α Orionis* as compared with their intensity in the sun. Apparently, they are even more prominent in *ο Ceti* than in *α Orionis,* as our measures have disclosed no other elements as certainly present in its spectrum. Stebbins doubts the presence of *Ti,* but the number of positive identifications in Nos. 486 and 515, and its analogy with the other sun spot elements, seem to offer conclusive evidence in its favour.

'As the spectrum does not extend much below λ 5000, only the bands in the blue-green are shown, but they are distinctly marked, sharply limited towards the red if considered as bright bands. They are brighter than the neighbouring bands, and fade off gradually towards the violet. There is one exception to this last statement however, the band beginning at λ 4626·0, which is of quite uniform intensity and sharply limited toward the violet at λ 4607·3. As the measures of plate 486 show, when the band was very distinctly and sharply limited, its edge was measured, and generally also the centre of intensity of the absorption line to the red side of the edge, but where not very sharply limited the absorption line at the red edge was measured. Taking these measures and estimating the distance of the edges from the measured positions, we get the following approximate wave-lengths:—

4954·0	Red Edge of Band
4847·5	" "
4804·5	" "
4761·4	" "
4626·2	" "
4607·6	Violet Edge of above band
4584·2	Red Edge of Band

'These measures are only given to the nearest tenth of a tenth-metre, as, owing to the poor focus in this region, they are not trustworthy beyond that limit.

'The spectrum of *ο Ceti* is very interesting, and will well repay a more extended study than has yet been given to it. Sufficient has been learned about it, however, to say that it is not necessarily identical at successive maxima, and this is very well shown by the behaviour of the $H\beta$ and $H\epsilon$ lines. It may be considered as well established now that it has a constant velocity of recession with respect to the sun of about 64 kms. per second and that the velocity determined from the bright hydrogen lines is some 15 kms. per second less. This difference of velocity is probably not real, the corresponding shift of the bright lines being produced by some other cause such as abnormal conditions of pressure, temperature, or electrical state in the atmosphere of the star.

'The difference in the spectrum of *ο Ceti* as observed here and at previous maxima may be summarized as follows:—

'1. Absorption Spectrum.

'Titanium, whose presence has been considered doubtful by Stebbins, is now very prominent as at least one fourth of the identifications of the prominent absorption lines measured in the two spectra appear to be due to this element.

'The magnesium line at λ 4571, which was undoubtedly bright in 1902, is now, quite as undoubtedly represented by an absorption line, which was measured in plate 515, and gives a velocity displacement in close agreement with the mean.

'The bands seem to end towards the violet at λ 4584, as in none of the negatives obtained here could any banded appearance be recognized below that limit. This is also clearly shown in the reproduction. The position of the bands in the blue green, however, agrees with Stebbins' values.

'2. Emission Spectra.

'$H\beta$ which at previous maxima had either been invisible or faint, is now of a decidedly emissive character, apparently over half as intense as $H\gamma$.

'$H\epsilon$ recorded by Stebbins as bright in 1902, but previously invisible, cannot be seen in any plate made here.

'There is no trace of the triple character of $H\gamma$ and $H\delta$ observed by Campbell, but no plates were made here at as early a date in the period as those obtained by him. $H\beta$, $H\gamma$, $H\delta$ are slightly asymmetric, more intense to the red side of the true emission line, similar to the later plates obtained by Campbell.

'No evidence, whatever, can be seen of the bright iron λ 4308 and λ 4376, observed by Campbell and Stebbins. The magnesium λ 4571 observed as distinctly bright by Stebbins is now represented by an absorption line. The bright lines λ 4202, λ 4216 and λ 4373, observed bright by Stebbins are not now present.

'Eight other bright lines are present in some of the negatives obtained here at λ 4233·4, λ 4229·5, λ 4178·8, λ 4173·6, λ 4165·8, λ 4138·5, λ 4119·6 and λ 4102·9. Of these the first and last have been seen bright by Stebbins and Campbell, respectively, and the third Stebbins considers as a bright space between absorption lines. There is no doubt in my mind that the first, fifth and sixth are emissive, but of the others I do not feel so certain.

'I acknowledge with thanks my indebtedness to Dr. W. F. King, the Director of the Observatory, for his interest and encouragement in the work, and to my assistant, Mr. W. E. Harper, who has very efficiently performed the greater part of the measurement and reduction, as well as assisting in the observing.'

APPENDIX C.

(Reprinted from the Journal of the Royal Astronomical Society of Canada, Vol. 1, No. 3).

'THE SPECTROSCOPIC BINARY α DRACONIS.

'W. E. HARPER.

'The star α Draconis R. A. $= 14^h\ 1{\cdot}7^m$, $\delta = +64^\circ\ 51'$. Visual Mag. 3·6, Phot. Mag. 4·0 has been under observation here intermittently since July, 1906. Up to Feb. 12 of this year 37 spectrograms in all had been secured. The radial velocities obtained from the measurement of these were used to obtain provisional values for the elements of the star's orbit. These provisional elements were announced in a previous number of this JOURNAL.

'In drawing the original curve more or less difficulty was experienced from the fact that there were certain intervals for which, owing to unfavourable weather, there had not been any corresponding observation. This was particularly the case at the maxima and minima. Furthermore since the measurements for velocity on the spectrograms already obtained were for the most part dependent on three lines; a faint *Fe* λ 4549, a sharp Mg. λ 4481 and a broad diffuse $H\gamma$ λ 4340, the resulting velocity was liable to be in error to the extent of say 5 kms. per sec. Three of the plates gave residuals from the computed velocity curve of upwards of 10 kms. but owing to the few lines in the spectrum this large discrepancy may probably be ascribed to accidental distortions of the photographic film, or it may be that the character of the spectrum of the star may have had something to do with the large residuals, as at times an apparent doubling of some of the lines was noticed. At any rate when the new spectrograph was put into regular use about the middle of May the time seemed opportune for securing more spectrograms of this star. This spectrograph with the single-prism attachment gives a flat field from about λ 3600 through the whole range of the visible spectrum. Although its linear dispersion is much less than that of the old spectrograph, the number of additional lines that can be measured *e.g.* $H\beta$ λ 4861, $H\delta$ λ 4102 and $H\epsilon$ λ 3970 renders the resulting velocity much less liable to error than would be the case with the former spectrograph. Nine more spectrograms have thus been secured, most of which fall in the gaps already alluded to.

'With the exception of the more recent negatives, for which a newer and shorter method has been evolved, the spectrograms have all been reduced by means of the Hartmann interpolation formula

$$\lambda = \lambda_0 + \frac{c}{s_0 - s}$$

where λ is the apparent wave-length of the line measured, s is the micrometer reading, and λ_0, c, s_0 are constants determined from known standard comparison lines with their corresponding micrometer readings. The difference between the measured wave-length of the stellar line and its normal wave-length gives us the displacement $d\lambda$ due to the approach or recession of the star. This displacement is easily converted into velocity by means of the simple formula

$$V_s = \frac{299{,}860}{\lambda} \cdot d\lambda$$

where V_s is the required radial velocity. To this velocity is then added a correction V_a due to the orbital motion of the earth and another V_d due to its axial rotation.

No allowance is made for the motion of the solar system through space; the resulting velocities are therefore relative to the sun.

'For the sake of brevity the Journal of Observations is omitted. The exposure time required in fair seeing was about 30^m with the single-prism, and about 55^m with the three-prism instrument, the slit-width being usually ·025 mm. Several plates were made on each of the nights November 1, November 6 and November 8. I suspected that the star might have a very short period, but the measures showed no rapid change of motion such as might be looked for in a short period binary and accordingly the mean of these measurements for each night was used. In the summary of velocities which follows the phase is given with each velocity. This is the time-interval after some initial epoch selected arbitrarily. I have taken the initial epoch when the computed velocity is zero and becoming positive, *i.e.*, $T_0 = 1906$, July 2, G.M.T., 0^h.

SUMMARY OF VELOCITIES.

Date.	Phase.	Velocity.	Date.	Phase.	Velocity.
1906					
July 2·67	0·67	+ 3	Dec. 17·75	14·61	− 7
" 4·75	2·75	+16	" 18·75	15·61	−17
			1907		
Aug. 15·59	44·59	−32	Jan. 9·67	37·53	−43
" 24·59	2·20	+ 6	" 11·75	39·61	−35
			" 21·67	49·53	− 6
Sep. 10·59	19·20	−30	" 30·71	7·19	+44
" 19·59	28·20	−42			
" 27·54	36·16	−42	Feb. 6·75	14·23	− 4
			" 12·62	20·10	−36
Oct. 3·5	42·12	−39			
" 18·5	5·74	+32	May 22·64	16·57	−18
			" 31·68	25·41	−38
Nov. 1·6	19·76	−40			
" 6·6	24·77	−44	June 8·78	33·50	−45
" 8·6	26·76	−45	" 10·7	35·42	−31
" 16·67	34·91	−50	" 11·6	36·32	−42
" 19·54	37·78	−54	" 20·64	45·36	−20
			" 21·69	46·41	−21
Dec. 7·71	4·57	+31			
" 11·8	8·65	+31	July 4·63	7·96	+56
" 13·54	10·40	+34	" 5·62	8·96	+45

'These values when plotted give us a period of about 51 days. To determine the period with greater accuracy it is necessary to take a series of observations extending over a long time and to divide the interval by the number of periods. For this purpose, of course, the longer the star is under observation the more accurately can the period be determined. Our observations extend over only seven periods, whereas observations made at other observatories taken in conjunction with our own give a range of over forty periods. The following are the only other observations made on this star, which are known to the writer.

PREVIOUS OBSERVATIONS.

Date.		Phase.	Velocity.	Observatory
	1901.			
November,	20·92	11·46	+20	Yerkes.
	1902.			
June	16·6	13·82	+ 1	Lick.
	1903.			
April	29·	22·54	−43	"
May	4·	27·54	−42	"
"	23·	46·54	−17	Potsdam.
"	24·	47·54	−14	"
	1904.			
June	19·	28·50	−42	Lick.
	1905.			
June	13·	27·84	−42	"
	1906.			
January	4·	27·22	−40	"
"	5·98	28·47	−42	Yerkes.
"	8·9	31·43	−55	"
"	26·89	49·41	− 9	"
"	29·81	0·95	+ 1	"
February	9·93	12·07	+24	"

'Reducing all the observations within the same period, we find

$$P = 51^d{\cdot}38$$

which is likely not much in error.

'It now remains to determine the remaining elements of the orbit from the curve shown. There are two methods; the geometrical, in which the elements are obtained from a consideration of the curve itself, its maximum and minimum points especially, and the areas enclosed by certain portions; the analytical, in which we have recourse to a Fourier series. The former method is that of Lehmann-Filhés; the latter is due to Russell. For orbits of small eccentricity the latter is the preferable I fancy, but in other cases the geometrical is more suitable. I have used the analytical method, and I shall briefly summarize it: Mr. J. S. Plaskett has computed the elements by the other method, and a comparison of the two will prove interesting.

'The velocity being a known periodic function of the time can be expressed in the form of a series of sines and cosines. Thus we may write

$$v = c_0 + c_1 \cos. \mu (t - t_0) + c_2 \cos. 2 \mu (t - t_0) + +$$
$$+ s_1 \sin. \mu (t - t_0) + s_2 \sin. 2 \mu (t - t_0) + +$$

where c_0, c_1 ..... s_1 s_2 ..... are constants determined from the curve, t the time at which the velocity is v, and t_0 the initial epoch. With a slight transformation this series can be put in the form

$$v = a_0 + a_1 \cos. [\mu (t - t_0) + \alpha_1] + a_2 \cos. [2 \mu (t - t_0) + \alpha_2] + \ldots\ldots \qquad (1)$$

in which the a's and α's are determinable from the c's.

'To get an analytical expression for the velocity let our fixed plane of reference be the one perpendicular to the line of sight, let

a = semi-major axis of the orbit
e = eccentricity
i = inclination of plane of orbit to our plane of reference
ω = longitude of periastron measured from the descending node
T = time of periastron passage
θ = true anomaly

M_0 = mean anomaly at time t_0
r = radius vector
V_0 = velocity of system of the whole.

We can then get the following expression for the velocity

$$v = V_0 + \mu\, a \sin.\, i\, b_1 \cos.\, [\mu\, (t - t_0) + \beta_1 + M_0] + \mu\, a\, e \sin.\, i\, b_2 \cos.\, [2\, \mu\, (t - t_0) + \beta_2 + 2\, M_0] + + \; . \; . \; . \; . \; . \qquad (2)$$

'The series (1) and (2) considered as functions of the time are of the same form. If they are to represent the same quantity their corresponding coefficients must be equal. Considering terms of e no higher than the first we immediately get preliminiary values of V_0, e, ω, a sin. i and M_0 from which by a series of approximations newer and more accurate values can be obtained.

'From the first curve arbitrarily drawn were obtained the elements

$e = 0{\cdot}40$
$\omega = 197°\ 16{\cdot}8$
$V_0 = -16{\cdot}9$ kms.
T = 1906 July 10·69

'These elements in turn were used to compute an ephemeris by using the two following equations:—

$$t = \frac{P}{2\,\pi} \cdot \left[2 \tan.^{-1} \sqrt{\frac{1-e}{1+e}} \tan. \frac{\theta}{2} - \frac{e\sqrt{1-e^2} \sin.\theta}{1+e \cos.\,\theta} \cdot \right]$$

$$v = \frac{A+B}{2} \cos.\, (\theta + \omega) + \frac{A-B}{2} \cdot$$

where t is the time required to describe an angle θ from periastron, v the corresponding velocity, A and B being velocities as designated in the Lehmann-Filhés method. By using values of θ differing by 10° thirty-six points were obtained through which the computed velocity curve was drawn. An examination showed that the original observed velocity curve could be brought into better agreement with the computed curve and still be in as good, if not better, accord with the observations. This was done and a new set of elements computed from this curve. These elements, differing slightly from the previous ones, were in turn used to obtain a second computed velocity curve. The agreement between these latter curves was much better than formerly but was still unsatisfactory. An increase in ω and T would improve matters and when this was done the agreement, though still imperfect, was fairly satisfactory.

'The residuals of all our observations from this second computed velocity curve were now taken and the probable error of a single observation $\left[r = \pm \cdot 6745 \sqrt{\frac{\Sigma\, v^2}{n-1}} \right]$ was computed. Our own observations gave $r = \pm 3{\cdot}4$ kms. but if the three discordant observations mentioned previously were omitted this was reduced to 2·6 kms. For the previous observations recorded $r = \pm 3{\cdot}6$ kms. but if we omit a discordant one of Frost's this would be lessened to 2·9 kms. For a star of this type this may be considered quite satisfactory.

'Following out the geometrical method Mr. Plaskett used his provisional elements to correct his original curve, from which corrected curve he determined his second and final set of elements. The agreement between his observed and computed velocity curves on this second approximation was sufficient without any further changes and I believe that for an orbit of eccentricity as great as this one under consideration the geometrical method is much preferable. The table of elements as determined by each follows:—

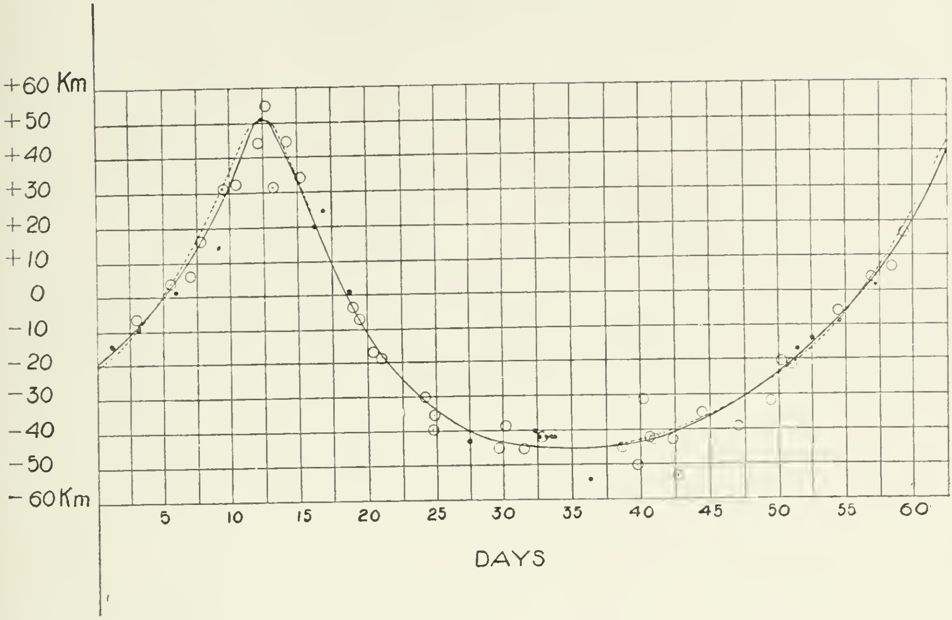


FIG. 1.—Velocity Curve of α Draconis.

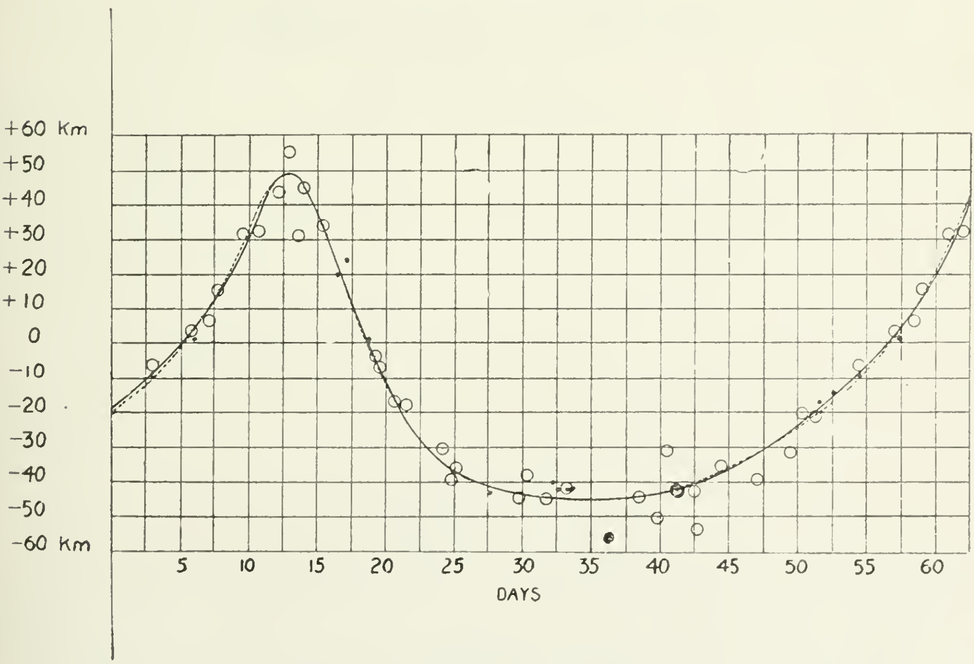


FIG. II.—Velocity Curve of α Draconis.

TABLE OF ELEMENTS.

Elements.	Harper.	Plaskett
P	$51^{d} \cdot 38$	$51^{d} \cdot 38$
V_{o}	$-16 \cdot 7$ kms.	$-17 \cdot 0$ kms.
e	$0 \cdot 42$	$0 \cdot 44$
ω	198 (from descending node)	20° 15′ (from ascending node).
T	1906, July $11^{d} \cdot 0^{h}$	1906, July $11^{d} \cdot 0^{h}$
a sin. i	30,057,900 kms	29,683,000 kms.

'Both sets of curves are shown; my own in Fig. I. and Mr. Plaskett's in Fig. II. The heavy line is the observed velocity curve while the dotted is the computed one. The small circles represent our own observations while the dots are those of other observers. A graph of the orbit is also shown.

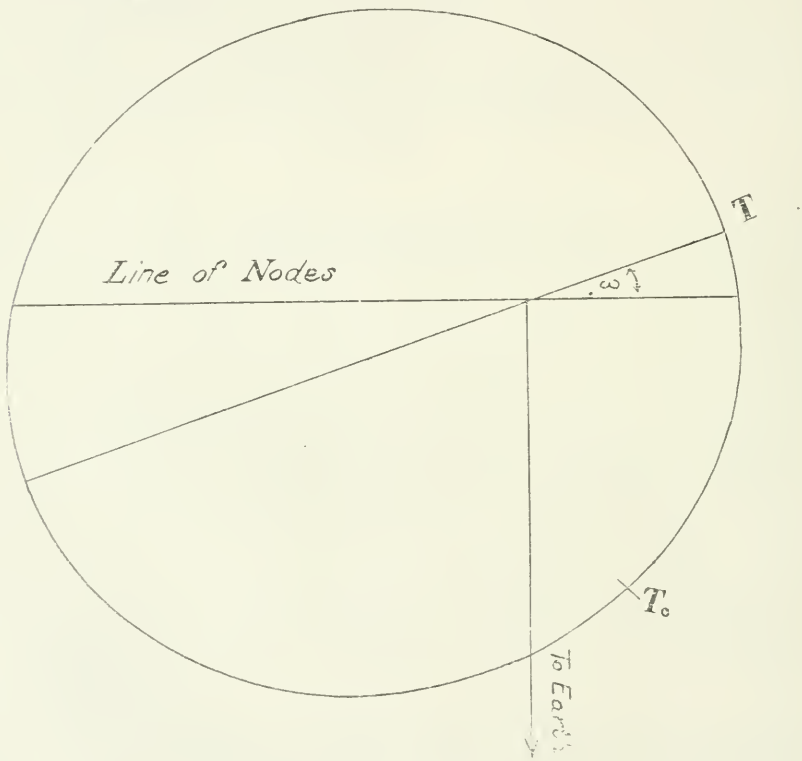


FIG. III.—Orbit of α Draconis.

'No attempt has been made to correct the elements by the method of least squares as the observations were not considered to be of sufficient accuracy to warrant such a procedure.

'I acknowledge with thanks my indebtedness to Mr. J. S. Plaskett, who throughout has given me much valuable advice and assistance; and I am glad also of this opportunity of expressing my appreciation of the kindly interest which the Chief Astronomer, Dr. W. F. King, has shown in the prosecution of this work.

'DOMINION OBSERVATORY,
OTTAWA, CANADA.

APPENDIX No. 4.

REPORT OF THE CHIEF ASTRONOMER, 1907.

TIME SERVICE SYSTEM.

BY

R. M. Stewart, M. A.

CONTENTS.

ILLUSTRATIONS.

APPENDIX No. 4.

REPORT OF R. M. STEWART, M.A., ON THE TIME SERVICE.

OTTAWA, ONT., March 30, 1907.

W. F. KING, Esq., B.A., LL.D.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to report as follows on the work carried out under my charge during the past fiscal year.

The ordinary work in connection with the Time Service, in addition to the necessary observations and daily routine work, has consisted mainly in the various extensions and improvements which seemed called for, or became possible, from time to time. The temperature control of the Standard clock has been greatly improved by the installation of the Callendar Recorder described below, and by the erection of the outer case in which it is now enclosed. The automatic arrangement for sending out time-signals has been completed, and has been extended from the telegraph lines to the telephone. The time service to the Government Buildings in the city has been continued, and extensions to other departments provided for. Some additional experimental work, such as time would permit of, has also been carried on. Experiments were made on the time of transmission of telegraphic signals through repeaters, and a few on the time-constants of relays; this work finds its application in longitude determinations and in general meridian observations. An attempt was also made to compare the relative accuracy of transit observations with the observing key and with the travelling-wire micrometer, which led to some interesting and rather unexpected results as described below.

CLOCK ROOM AND APPARATUS.

As stated in my last report, the method of temperature control in use in the clock room at that time had not proved very satisfactory. This was owing to irregular variations of the zero point of the brass-ebonite thermostat which controlled the heating circuit, due to changes in length of the ebonite section, corresponding to fluctuations in the amount of humidity in the air of the room. A Callendar Recording Thermometer with a special attachment was ordered to overcome this difficulty, and was received in December last.

The recorder is essentially a self-balancing slide-wire bridge, in one arm of which a platinum resistance thermometer is inserted; the resistance of the latter serves as a measure of the temperature, while the record is made by a pen attached to the sliding contact. Fig. 1 is from a photograph of the complete instrument, while the circuits are shown diagrammatically in Fig. 2. One side of the bridge-circuit consists of two fixed resistances of ten ohms each; the other comprises several adjusting coils, the slide-wire, and the thermometer; the galvanometer is connected across in the usual way. The self-balancing feature of the instrument depends on the fact that the galvanometer, which is of the D'Arsonval type, acts as an extremely sensitive relay; attached to the moveable coil is a long light arm consisting of two insulated wires which terminate in the two prongs of a fork, enclosing a small contact wheel. The wires lead respectively to two 'motor release magnets,' each of which, when energized, serves to lift a brake off the corresponding one of two motor-clocks and allow it to work; these motor-clocks are connected by differential gearing with a sliding carriage which makes contact with the bridge wire. In this way, when the balance of the instrument is disturbed by a change in the temperature of the thermometer, the galvanometer tends to deflect either to one side or the other, and thus completes the circuit through one or other of the motor release magnets; the corresponding motor clock then pulls the carriage along the slide-wire till the balance is restored. The motor-clocks are connected differentially to a driving spindle whose direction is perpendicular to that of the motion of the carriage; a cord with two or three turns around the spindle passes over pulleys near each end of the bridge wire, and its two ends are fastened to the opposite sides of the carriage, so that a rotation of the spindle draws the carriage in the corresponding direction. To the carriage is attached a pen which traces the temperature-curve on a sheet of paper ruled to the proper scale; the paper is moved by a driving clock at the rate of 1 c. m. per hour, a strip 1·68 m. in length lasting for a week.

The adjusting coils mentioned above consist of an 'ice bobbin' of manganin wire, having the same resistance as the platinum thermometer at 0° C, a balancing coil of about the same resistance as the bridge wire, and a zero coil whose resistance depends on the lower range required for the instrument; also a rheostat of low resistance for the final adjustment.

The instrument is connected to the thermometer by leads consisting of two pairs of wires; one pair (from PP, Fig. 2) is attached to the thermometer itself, the other pair (from CC), which is inserted in the opposite arm of the bridge, is short-circuited at the thermometer; as a result, the temperature of the leads, however much it may vary, does not affect the recorded temperature.

The range of the instrument depends on the resistance of the bridge wire, the zero point on that of the zero coil. If I, Z and W denote respectively the resistances of the ice bobbin, the zero coil and the bridge wire, B that of the balancing coil and rheostat, and P_0 that of the thermometer at 0° C, we have, since $I = P_0$ and $B = W$

$$I + B = W + P_0 \qquad (1)$$

Also, if T_1 is the temperature corresponding to the zero of the instrument, and a the temperature coefficient of resistance for platinum,

$$I + B + Z = W + P_0 \ (1 + a\, T_1) \qquad (2)$$

Hence $Z = P_0\, a\, T_1$

$$\text{or } T_1 = \frac{Z}{P_0\, a} \qquad (3)$$

Again, if T_2 is the upper limit of the scale,

$$I + B + Z + W = P_0 \ (1 + a\ T_2) \qquad (4)$$

and by combining (2) and (4)

$$2\ W = P_0\ a\ (T_2 - T_1)$$

$$\text{or } T_2 - T_1 = \frac{2\ W}{P_0\ a} \qquad (5)$$

For our instrument the present range is from 10° C to 35° C, corresponding to a distance of 200 m.m., or 8 m.m. per degree, which gives a fairly high order of sensitiveness; the range can of course be changed to any value by altering the resistances of the bridge wire and zero coil. The resistances of the several parts are approximately:—

	Ohms.
Thermometer (at 0° C)	10·8
Bridge wire	·5
Ice bobbin	10·8
Zero coil	·4
Balancing coil	·25
Rheostat	·25
Galvanometer	10
Motor release magnets (each)	30

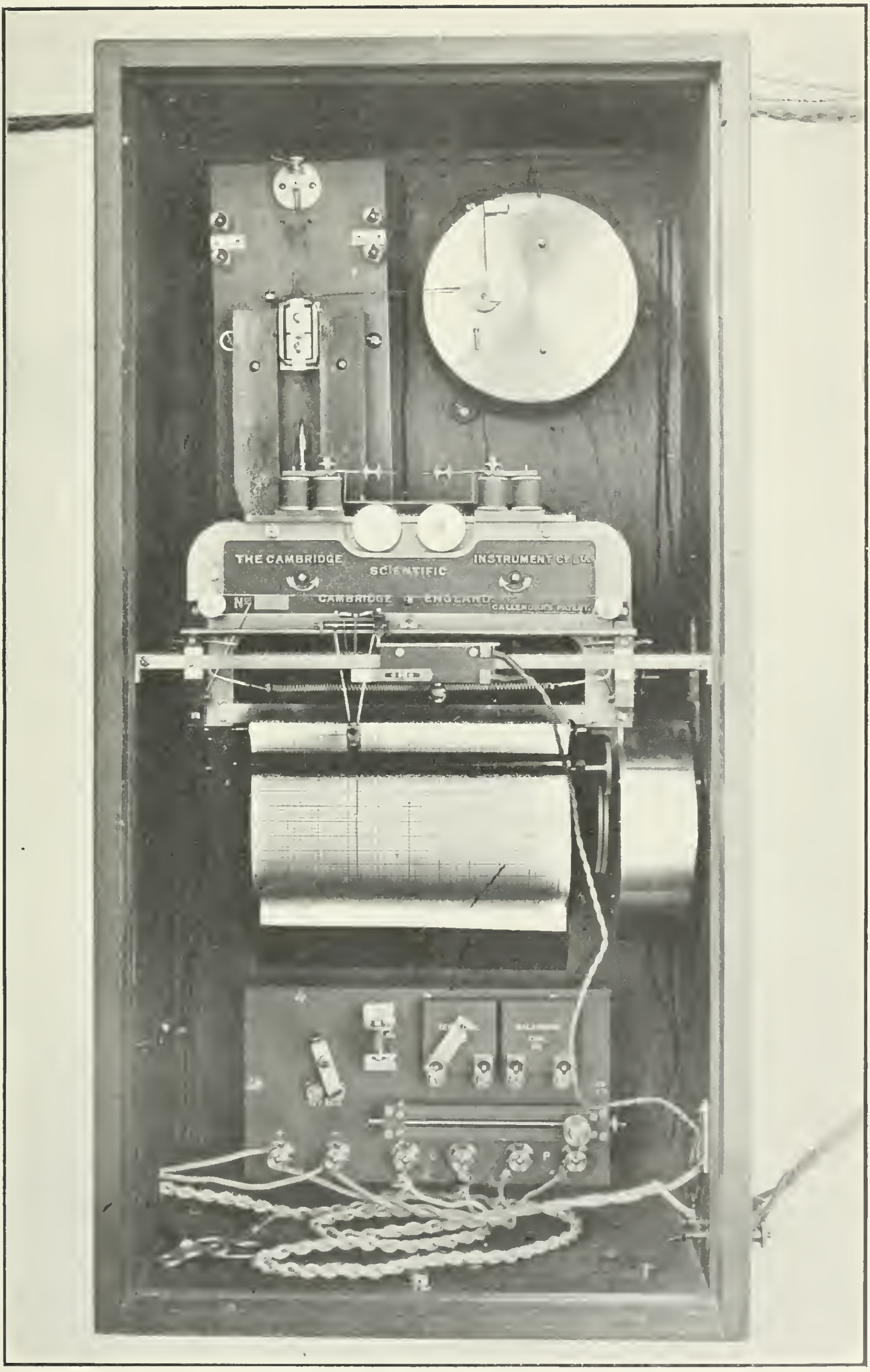


FIG. 1.—Callendar Electric Recorder.

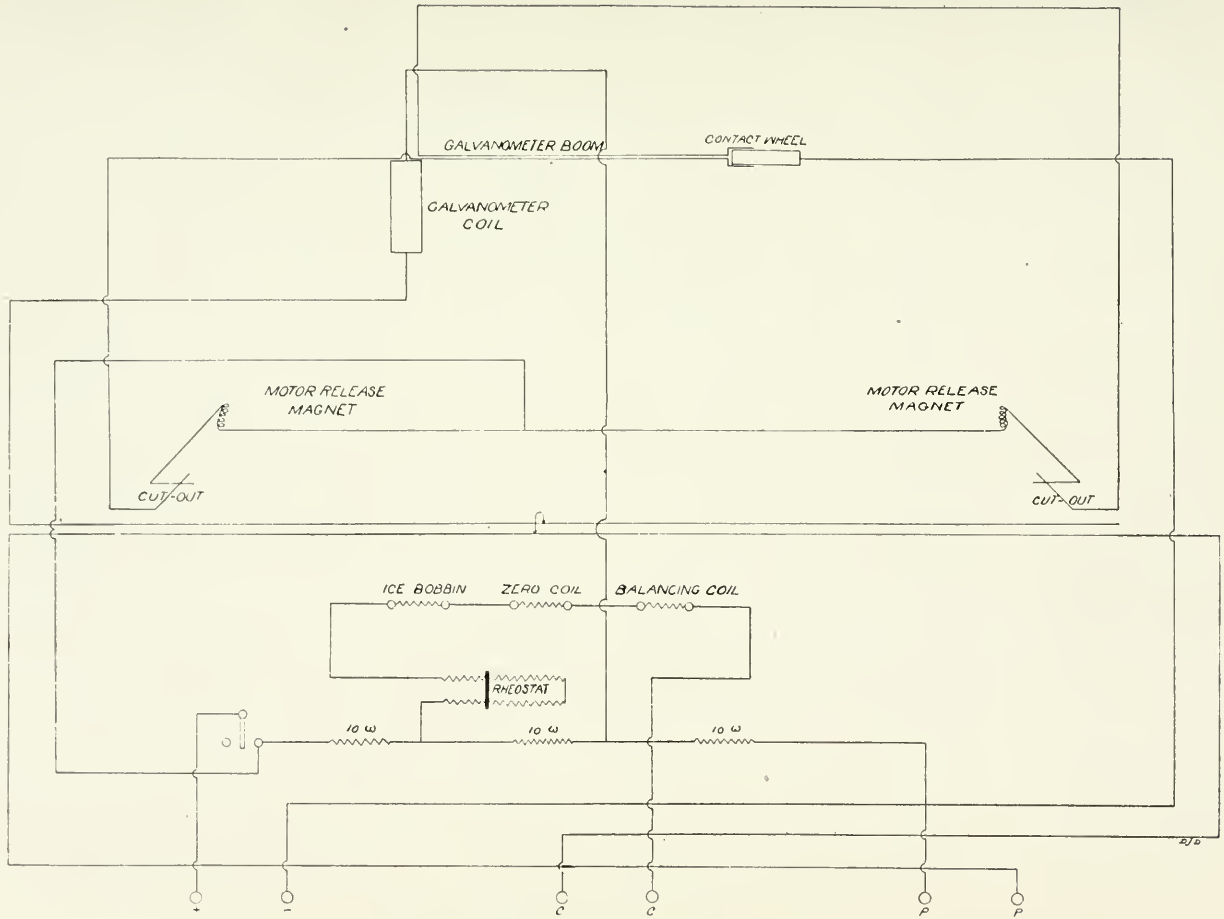


Fig. 2.—Electric Circuits of Callendar Recorder.

The thermometer consists of about ten feet of open-wound platinum wire, mounted on a frame about six inches square; the open winding is advantageous in that it renders the thermometer particularly quick to take up the temperature of the surrounding air; it is a type introduced recently for meteorological purposes.

These instruments are used usually merely for measuring and recording temperatures; as it was in this instance required to control the temperature as well, an additional attachment was necessary. A brass rod is fixed parallel to the bridge wire, and on it slides a brass frame capable of being clamped in any desired position; this carries an electric contact which is closed by the pen carriage when the temperature drops to the corresponding value; the contact operates the relay which controls the heating circuit.

The chief advantages of the instrument are:—

1. Constancy of the zero point.

2. The temperature recorded is free from the influence of all mechanical errors, such as friction of the pen on the paper, backlash, &c.; this follows from the fact that the balance depends only on the position of the pen-carriage with respect to the bridge-wire.

3. Only the platinum thermometer need be in the position whose temperature is to be measured or controlled; the rest of the instrument may be situated at any distance or in any position convenient.

With regard to the last point, it is necessary to consider the effect of a difference in the temperatures of the thermometer and recorder, or rather, in this case, since the temperature of the thermometer is practically uniform, of variations in the temperature of the recorder. If the sliding contact be placed at a distance x from the lower end of the scale, the whole length of the scale being considered unity, and if the actual temperature at which the thermometer is thereby kept be T, we will have, using the same notation as before,

$$I + B + Z + x\,W = (1 - x)\ W + P_0\ (1 + a\,T) \qquad (6)$$

Now the temperature coefficient of resistance of manganin wire is practically zero;* hence without sensible error we may put $I = P_0$. Also, since the wires B and W are at the same temperature, $B = W$ for all temperatures (provided they are of the same material).

Thus (6) reduces to

$$Z + (1 + x)\ W = (1 - x)\ W + P_0\,a\,T$$

$$\text{or } T = \frac{Z + 2\,x\,W}{P_0\,a} \qquad (7)$$

Again, if t be the temperature of the recorder,

$$\frac{d\,T}{d\,t} = \frac{Z\,a' + 2\,x\,W\,a'}{P_0\,a} = T\,a' \qquad (8)$$

where a' is the coefficient for the wires Z and W, supposed of the same material. Ordinarily T is about 25° C, and if we put $a' = 3{\cdot}6 \times 10^{-4}$ (the approximate value for German silver), we arrive at the result that a fluctuation of 1° C in the temperature of the recorder will entail a variation of about ·01° C in the controlled temperature. If the variations in t were very large this might be objectionable; in that case the effect might be reduced by removing the coils B and Z and inserting them in the compensating leads beside the thermometer. In that case we should have in (6), $I = P_0$, $B + Z =$ a constant $= R$, say, and the equation reduces to

$$R + x\,W = (1 - x)\ W + P_0\,a\,T$$

$$\text{or } T = \frac{R}{P_0\,a} + \frac{(2\,x - 1)\ W}{P_0\,a} \qquad (9)$$

$$\text{Hence } \frac{d\,T}{d\,t} = \frac{(2\,x - 1)\ W\,a'}{P_0\,a} \qquad (10)$$

---

* Smithsonian Physical Tables. Coeff. for manganin at 20°—30°C = 1·4 x 10^{-5}.

Substituting the value of W from (5), and noting that

$$x = \frac{T - T_1}{T_2 - T_1} \text{ very nearly, (10) becomes}$$

$$\frac{dT}{dt} = \left[T - \frac{T_1 + T_2}{2} \right] a' \qquad (11)$$

In this case the variation per degree varies from zero at the centre of the scale to about ·005° C at either end; for $T = 25°$ C it amounts to only ·001° C.

The instrument was set up in the time room on its arrival, and connected by the compensating leads with the thermometer, which was hung near the centre of the clock room. It was discovered that the manganin ice-bobbin was missing, and pending the arrival of a new one it was replaced for testing purposes by a coil of German silver wire of the proper resistance. After a test, it seemed that there would be no necessity of removing the coils B and Z to the clock room, and they have been left up to the present in their places in the recorder. After connection with the heating circuit, the temperature in the immediate vicinity of the thermometer was kept easily within ·1° C, which is probably quite close enough for practical purposes. After a time, however, it developed, as might indeed have been expected, that at some distance from the thermometer the variations were considerably in excess of this value, amounting sometimes to perhaps half a degree. In view of the fact that the temperature error of the Riefler clock is somewhat larger than might be desired, it seemed advisable to take some further precautions against variation. While perfectly aware that by many experts it is considered useless to attempt any extreme refinement in temperature control, it has always been my impression that, with this clock at least, temperature is the largest source of error; this feeling was strengthened by its improved performance after the installation of the recorder, and it seemed well worth while to attempt still further improvement. This was deemed advisable not so much for the purposes of the time service as such, but because of the great advantage to be derived in refined meridian work from the highest possible uniformity in clock rate.

The plan adopted was to inclose the clock in an outside heat-proof case whose temperature should be controlled by the recorder, and to keep the less important clocks and the room at large at a fairly uniform temperature by other means. The plan of the case in section is shown in Fig. 3. The outside walls consist of layers of different substances, with an air-space, to prevent loss of heat, and two doors are provided at one side to allow access when necessary. The main part of the case is filled by the pier and clock; behind this a partition extending nearly to the top incloses a space for the electric heater; in the small chamber at the back is situated an electric fan which keeps up a constant circulation of air through the heater and around the clock as shown by the arrows in the figure. The platinum thermometer connected to the recorder is fixed directly above the clock. Two windows of double glass are provided at the level of the clock movement, one in front, the other at the side; for convenience in reading the thermometer and barometer in the clock, a mirror is fixed in a suitable position inside the case. This arrangement was completed and installed in February, and the temperature control is now quite satisfactory; its sensitiveness is exhibited by the fact that the heating circuit is turned on and off on an average about once a minute, while there appears to be no measurable change in the temperature.

The air-tight case of the Riefler was last exhausted and sealed on June 29th, 1906, after replacing the damaged bushing by an improved one; from that time up to the date of this report the leakage, if any, has amounted to less than a millimetre. Some data as to the performance of the clock are contained in Table V. below, and will be referred to later; during the period considered the outside case had not been installed, but the temperature was controlled by the Callendar recorder.

Some time ago a clock was sent to the Chief Astronomer by Louis Fontaine, D.L.S., of Lévis, acting for the estate of the late D. C. Morency, to be tested, with a

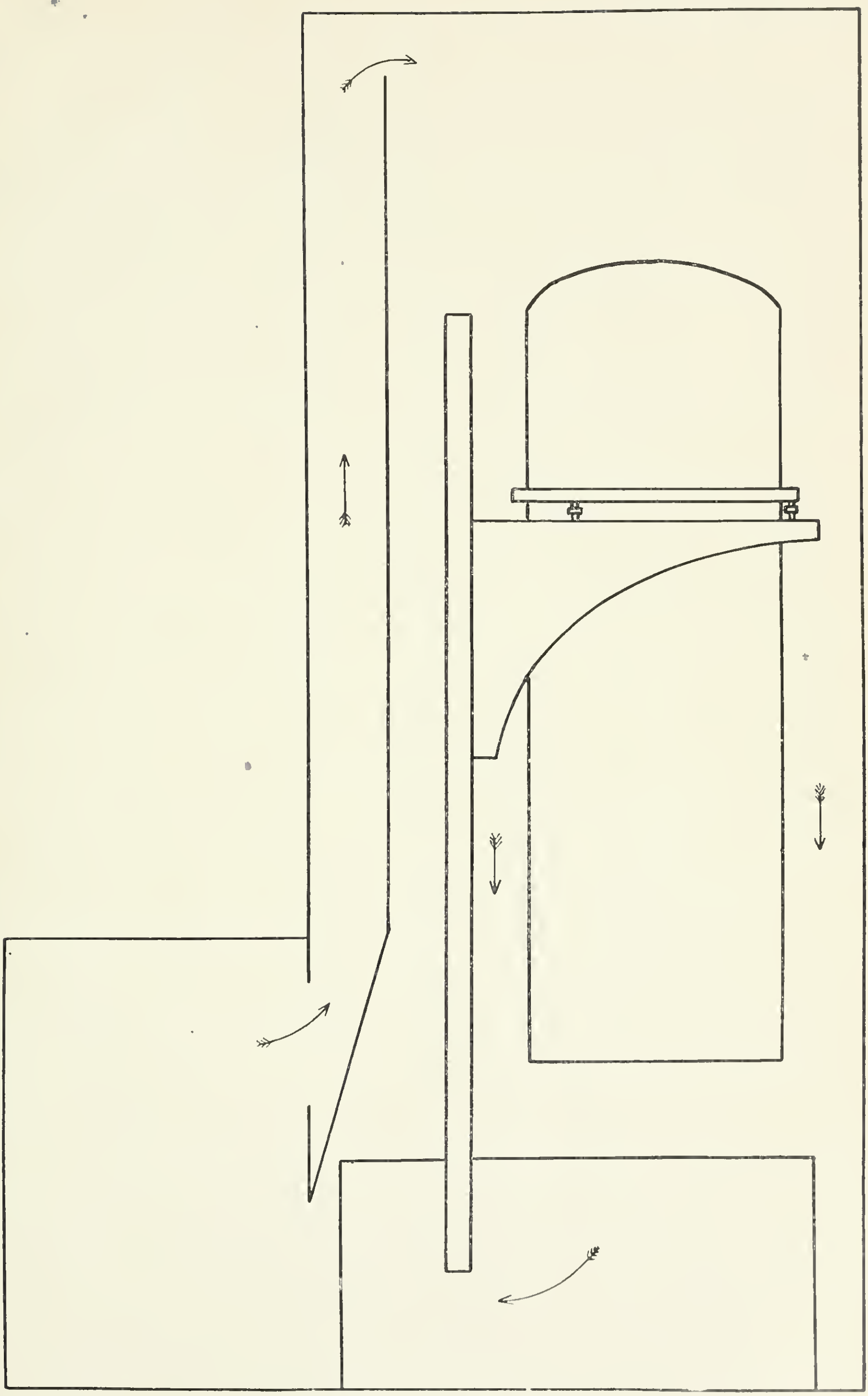


Fig. 3.—Plan of Outside Case of Riefler Clock.

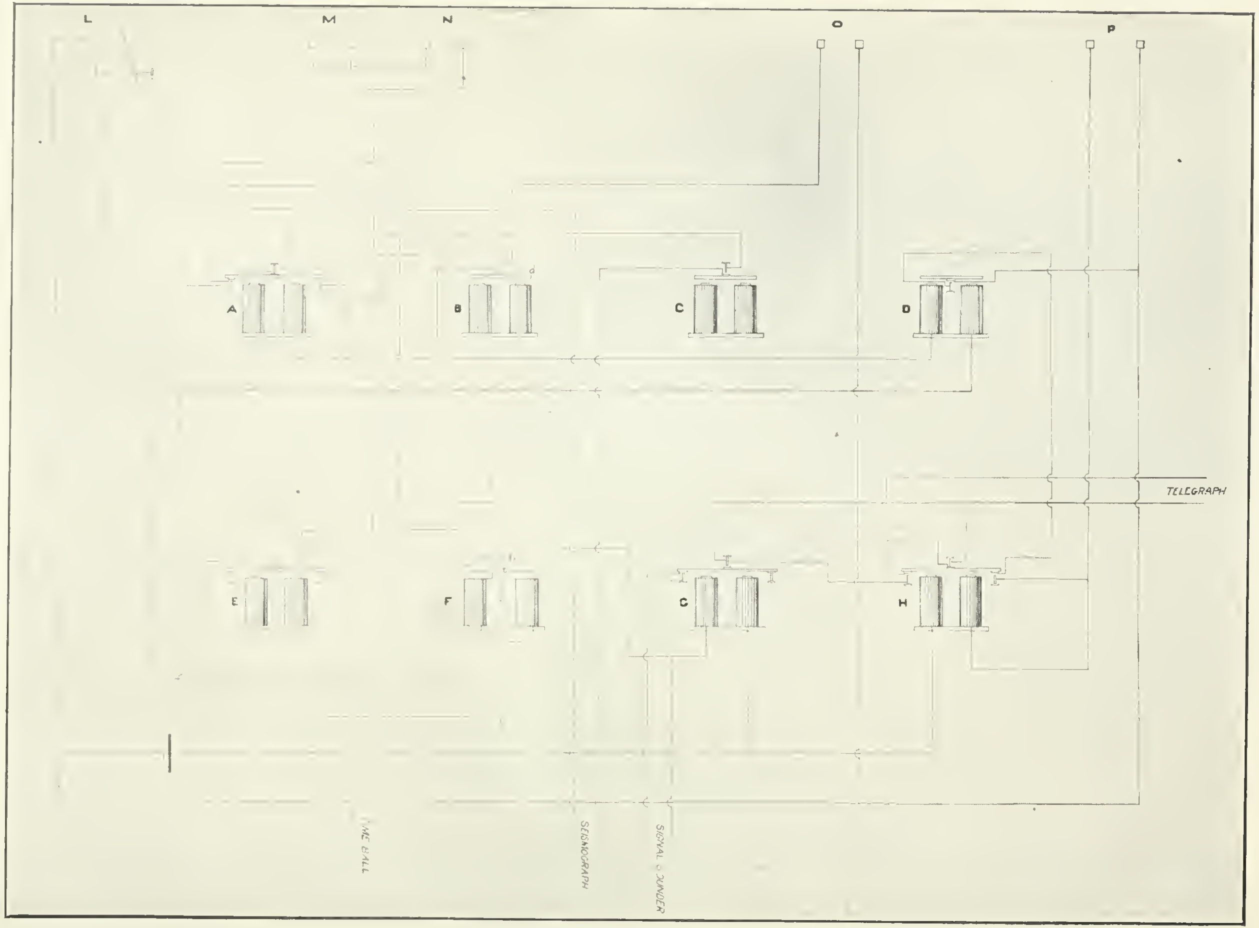


FIG. 4.—Time Signal Circuits.

view to purchase if found satisfactory. The compensation is a mercury one, the pendulum being supported directly from the movement; the escapement is of the dead-beat type. Some preliminary tests of its performance were made in the time room, without any very firm mounting, with the result that its variations of rate were very considerable. However, examination showed that a large part of its irregularity was due to imperfect compensation. The addition of a sufficient quantity of mercury to remedy this defect raised the centre of gravity to such an extent that it could no longer be regulated to keep mean time; accordingly it was rated to sidereal time and a second test made in the clock room. To facilitate comparison, a temporary seconds-contact was attached by arranging a drop of mercury beneath the lower extremity of the pendulum rod. The result of this test showed such a decided improvement as to warrant the conclusion that with some alterations the clock would perform quite creditably, and it was accordingly purchased. The chief alterations required are a firmer suspension of the pendulum and a more rigid attachment of the mercury cup to the pendulum rod, with the addition of the necessary electric contacts. Pending these changes, the clock is at present not in use.

TIME SIGNAL CIRCUITS.

As intimated in my last report, the operation of the circuit in use at that time for sending out time signals was not very satisfactory. The contact controlling the time-signal relay was operated by a wheel in the signal clock which contained 54 teeth and six blank spaces, the latter corresponding to the beats omitted in sending the signals; in this way the signals corresponded in time to the audible beats of the clock. The difficulty encountered was that these beats were not absolutely uniform at different parts of the revolution; the explanation lies in a lack of trueness of the escapement, which is of the pin-wheel type, and so particularly liable to this defect. The remedy evidently lay in making the contact depend, not on the escapement, but on the pendulum. For this purpose the original seconds-contact of the clock, designed for operating seconds dials, was made use of. It consists of two springs, fixed one on each side of the pendulum rod near its upper extremity, and connected together electrically, which make contact alternately with two adjustable screws fixed to the clock-case. This circuit, among others, is shown in Fig. 4, and its working is described below. It was preferred to the arrangement of a mercury drop beneath the pendulum because of the greater firmness and certainty of its action, and also for the sake of uniformity, as the beats can be adjusted to occur sensibly at the same time as the audible beats of the clock, as is the case with electrically driven minute dials and seconds dials.

The arrival of the program clock made it possible to arrange for the automatic action of the signal circuit, and this made necessary a re-arrangement of the circuits controlled by the signal clock. The program clock is of the minute-dial type ordinarily used for ringing bells, and controls two separate circuits. A graduated paper ribbon of a length corresponding to twelve hours is driven by a drum actuated every minute by the impulses of the master-clock; two springs press against the ribbon, being insulated by it from the drum; perforations in the ribbon serve to close the respective circuits at any required time or times. There is also a wheel revolving once a week which may be utilized if required for cutting out either circuit or both at nights and on Sundays or holidays.

In arranging the signal circuit the requirements were that the signal relay should beat seconds, omitting, however, the 29th second and the last five seconds of every minute as well as the last ten seconds of every fifth minute; in addition, it was to give a single beat of one second duration exactly at the even hour, and to remain quiescent for the next ten or fifteen seconds. The telegraph line was to be switched over the points of this relay at 11.55 a.m., and to remain so till a few seconds after noon. This could not be done by the program clock alone, as, being of the minute-dial type, it can control a circuit for only an integral number of minutes. The somewhat complexly interconnected system of relays found necessary for this and the other circuits controlled by the clock is shown in Fig. 4. *L* is the pendulum contact mentioned above which is closed for about half a second as the pendulum swings to either side; *M* is a contact controlled by a wheel revolving once a minute, which closes its circuit during the 29th second, and the last five seconds, of every minute; *N* is the contact controlled by the five-minute wheel previously used, closing the circuit from the 50th to the 58th second, of every fifth minute. *O* is the hourly contact, closed from about half a minute before the even hour till a few seconds after; *P* is the contact in the program clock, set to close from 11.55 a.m. to 12 noon. The other contacts and their circuits are omitted for simplicity; one closes its circuit for the first second of every minute, another is closed from the 59th to the 60th second (for operating minute dials), and the third is continuously closed except from the 58th to the 60th second.

The relay *E* is connected in series with the first of these and the hourly contact *O* (circuit not shown); it is actuated for one second exactly at the even hour; from its right-hand pair of points is controlled the circuit running to the time-ball on Parliament Hill. *B* and *C* are worked by the circuit which is open only from the 58th to the 60th second, so that the circuits through their points are closed (see figure) during these two seconds. *A* is operated by a combination of the hourly contact *O* and the relay *B*; the circuit passes from battery through the coils of *A*, thence in multiple through the right hand points *c* of *A* and the points *d* of *B*, thence to *O* and so back to battery. *O* is closed half a minute before the hour, but the circuit still remains open at *c* and *d*; it is, however, closed at *d* at two seconds before the hour, which energizes *A* and draws the armature down, closing *c* and thus leaving the circuit completed even after *d* opens at the 60th second; finally the circuit is opened at *O* after the lapse of a few seconds. In this way *A* is energized from two seconds before the even hour till ten or fifteen seconds after. The circuit for recording on the seismograph passes in series through the points of *C* and the middle points of A, thus operating the shutter every minute except that corresponding to the even hour.

F is a differentially wound, neutrally adjusted polar relay; its two pairs of coils are connected one with each side of the pendulum contact *L*; consequently, since it is neutrally adjusted, its action consists of a motion of the tongue *t* to right or left once a second, corresponding to the instants at which the pendulum makes contact at either side. The points *a* and *b* are connected, and a circuit passing between them and *t*, and also through the centre points of *E*, operates the signal relay *G*, which is held closed except at the instant when *t* is passing from *a* to *b* or from *b* to *a*. Consequently the relay *G* beats seconds; the single beat of a second duration every hour is obtained by the action of *E* already described. The omission of the required beats every minute and every five minutes respectively arises from the connection of the contacts *M* and *N* in multiple with *a b* and *t*. The condition that the relay shall remain quiescent for a few seconds after the hour is fulfilled by also connecting *a b* and *t* with the left-hand points of *A*.

The relay *H* is operated by a combination of the program clock contact *P* and the relay *D*, which works in unison with *A*. The circuit is closed at *P* at $11^h\ 55^m$ a.m., and remains so till $12^h\ 00^m$; at $11^h\ 59^m\ 58^s$, however, an alternative circuit is afforded by *D* through the right-hand points of *H*, which remains effective till opened by *D*; the result is that *H* remains energized from $11^h\ 55^m$ till a few seconds after noon. During this period the telegraph line is by it passed over the points of the signal relay *G*, and the clock-beats are thereby transmitted over the line.

An arrangement has also been installed by which the same system of clock-beats can be transmitted by telephone at any time. A telephone transmitter connected with the desk telephone is fixed under my desk in the time room, and immediately in front of it is mounted a telegraph sounder with a switch conveniently situated, so that it can at will be connected with the signal relay. The beats are sharp and clear, and of sufficient intensity to be heard even over the long-distance telephone lines; the arrangement has been in use since about the beginning of November and has been in frequent demand by jewellers, surveyors and other parties who require exact time. Methods of time transmission similar to the above have been in use for some time in different localities in Europe, notably by Dr. S. Riefler of Munich.*

UP-TOWN SERVICE.

The time service to the Government Buildings in the city has been continued practically unchanged; a few additional clocks have been installed in some offices, and clocks have been moved from one office to another in several cases as required. The new contacts installed in the master-clocks have given every satisfaction, and have materially improved the service. Some trouble was experienced with the tower clock at the Observatory during the past winter, and was traced to an occasional failure of good contact between the brushes and commutator of the motor; it was remedied by the addition of a small 'trailer' brush consisting of a thin strip of brass bearing on the commutator slightly behind the main brush; the chance of the two contacts failing together has proved negligible. The necessary attention to the up-town circuits has continued under the charge of Mr. D. Robertson, of the Observatory staff; it affords me pleasure to take this opportunity of stating that Mr. Robertson's care and attention to detail in this connection leave nothing to be desired.

An extension of the service has been projected during the past year, designed to include the city Post Office, the Printing Bureau, the Mint and the Archives Building. The plan contemplated involves the connection of the last three by underground wires, to be served by one master-clock. It is also proposed to install an electric tower clock in the post office, to replace the one formerly in use there. Under the instructions of the Chief Astronomer, the buildings in question with the exception of the Mint, were visited by me and an estimate made of the number of dials required for efficient service. In the case of the Mint, the estimate was made from the plans of the uncompleted building, and may require modification. The apparatus required, including master-clocks, dials, switch-boards and switch-board apparatus, batteries, motor-generators, &c., as well as the tower clock, has been ordered, and most of it has been received. In the appended list is given the total number of electric dials now in place or projected.

Parliament Building	44
Eastern Block	35
Western Block	60
Langevin Block	48
Thistle Block	2
Observatory (including tower clock)	27
Post Office (including tower clock)	21
Printing Bureau	29
Mint	29
Archives Building	7
Total (including 2 tower clocks)	302

ARMATURE-TIMES OF REPEATERS AND RELAYS.

In the telegraphic comparisons of time which form a part in determinations of longitude, it is usually assumed that the time of transmission of the telegraphic signals is the same in either direction. Where the highest accuracy is not required, as in stations used only for cartographical purposes, this assumption is undoubtedly

* Zeitübertragung durch das Telephon, by Dr. S. Riefler, in Zeitschrift für Instrumentenkunde, Feby., 1906.

sufficiently near the truth; but in the determination of important stations the question requires to be considered whether any errors are liable to arise from this or similar causes. This matter came up for discussion in 1906 in connection with the determination of the 141st meridian, and the duty of making some laboratory tests was entrusted to me by Dr. King.

The method in use here for making the telegraphic time exchanges is as follows:—In the telegraph line connecting the stations there is inserted, at each station, a 'signal relay,' over the points of which the chronograph circuit passes, as well as over those of the 'clock relay'; by this arrangement any signals sent over the line will be recorded on both chronographs, together with the beats of the respective clocks. To make the exchange, each observer sends a certain number of arbitrary break-circuit signals, which, being recorded on both chronographs, afford a comparison of the clocks at the respective stations. Suppose both clocks to be regulated to exact local time, and let t_{ew} and t_{we} denote the time of transmission of a signal from east to west and from west to east respectively, while δt_e and δt_w denote the 'armature-times' or 'reaction-times' of the eastern and western signal relays. Then if the eastern observer opens the signal key at an instant T, that signal will be recorded on his chronograph and on the western one at times T_e and T_w, where

$$T_e = T + \delta t_e \qquad (12)$$

$$T_w = T - L + t_{ew} + \delta t_w \qquad (13)$$

L being the difference of longitude. Hence we have

$$L - t_{ew} + \delta t_e - \delta t_w = T_e - T_w = \Delta T, \text{ say} \qquad (14)$$

Similarly, from the western signals,

$$L + t_{we} + \delta t_e - \delta t_w = T_e' - T_w' = \Delta T' \qquad (15)$$

and from (14) and (15)

$$L = \frac{\Delta T + \Delta T'}{2} + \frac{t_{ew} - t_{we}}{2} + \delta t_w - \delta t_e \qquad (16)$$

Of the quantities in (16), ΔT and $\Delta T'$ are the only ones which are directly measured, and it is customary to assume that $t_{ew} = t_{we}$, and $\delta t_w = \delta t_e$. In the case of a single telegraph line there is no reason for supposing t_{ew} and t_{we} to be unequal, but where repeaters are included in the circuit the case is different; there is no guarantee that the time of transmission through the repeaters themselves shall be the same in both directions, and any departure from this condition will enter directly into the final longitude. To determine this point a set of Milliken-Hicks repeaters was obtained through the courtesy of the C.P.R. Telegraph Company, and a number of tests made as described below.

As the principle of operation of repeaters is perhaps not a matter of general knowledge, a diagram of the connections is shown in Fig. 5 to illustrate their working. L_1 and L_2 are the line relays at the respective stations, R_1 and R_2 the repeaters proper, controlling respectively the transmitters T_1 and T_2. T_1 has two pairs of contact points, one controlling the line circuit to L_2, the other the adjusting relay A_2; similarly for T_2. The armatures of A_1 and R_1 (also of A_2 and R_2) are independent, but arranged as shown in the figure, so that when A_1 is unenergized its armature may hold the points of R_1 closed, even though no current be flowing at the instant through the coils of the latter. V is the line battery, with one end grounded, E the local battery for operating the transmitters and adjusting relays. The figure shows the condition when the operator at L_2 has his key open. Evidently the times of transmission in opposite directions have no necessary connection; that from left to right consists of the sum of the armature-times of R_1 and T_1, that from right to left of the same quantities for R_2 and T_2. The armature-time of any given relay depends of course on the amount of current normally flowing through it, and also on its adjustment, *i.e.*, on the closeness of the magnets to the armature and the tension applied to the latter.

In longitude exchanges only 'break-circuit' signals are employed, as under ordinary conditions the time of transmission of these is very much less than for the

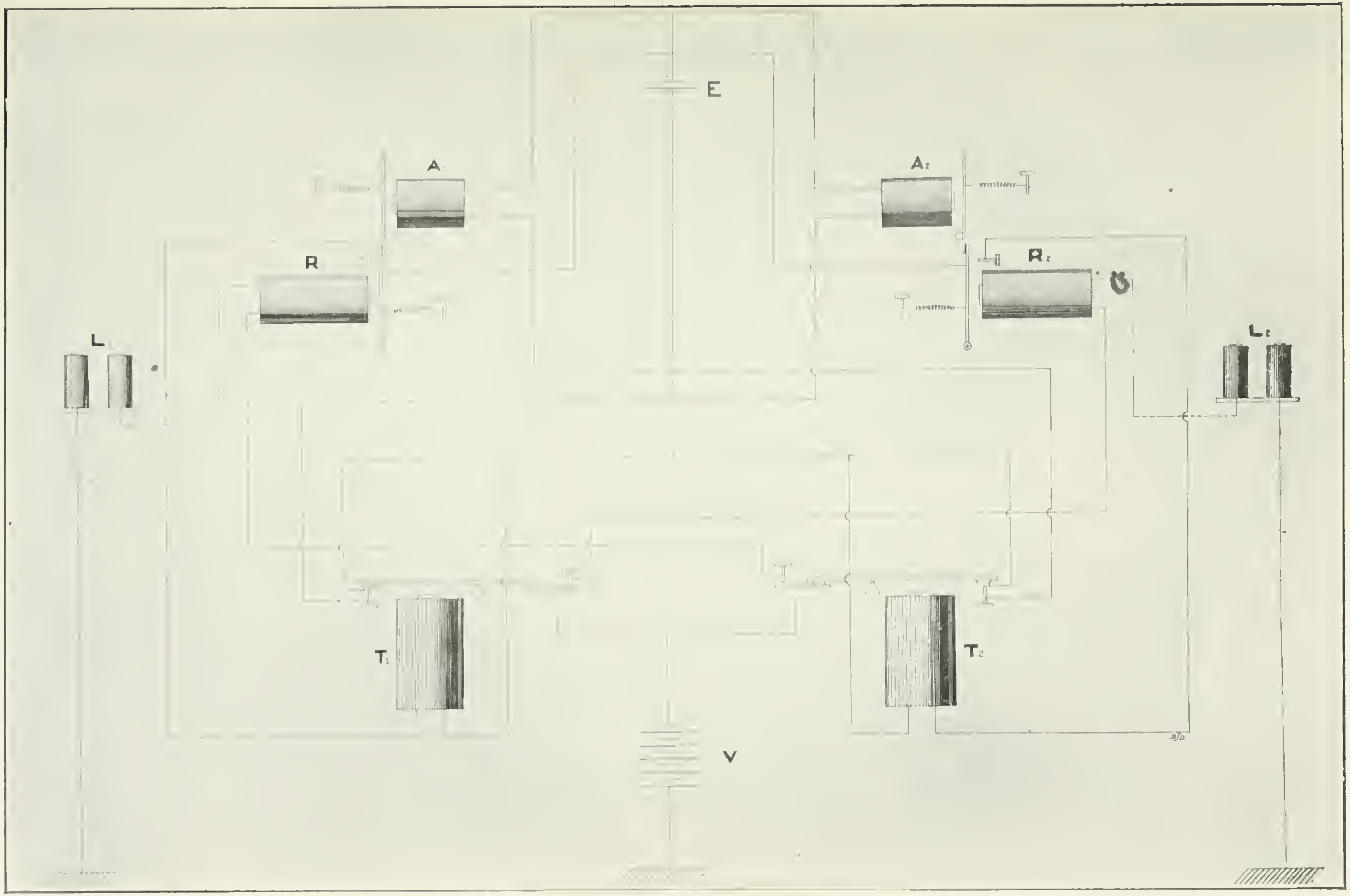


FIG. 5.—Connections of Milliken-Hicks Repeaters.

other type; consequently these were the only ones experimented with. The first experiment consisted in measuring the time of transmission in both directions under different conditions of adjustment, due care being taken that all the adjustments were perfectly normal, and such as might easily occur in actual work. The relays L_1 and L_2 were made to record one on each half of a double chronograph; to save time in scaling, as well as to eliminate errors in the determination of parallax, a clock was made to record on the chronograph simultaneously; the clock times of the signals sent and received could thus be scaled directly, their difference giving the time of transmission; in order that no individual peculiarities of the two coils of the chronograph might enter into the result, the connections were interchanged during the progress of each measurement. The times of transmission east and west are given below for each adjustment:—

	E.	W.
First adjustment.	·015 sec.	·054 sec.
Second adjustment.	·016 "	·069 "
Third adjustment.	·014 "	·034 "
Fourth adjustment.	·039 "	·008 "

Each of these values is from the mean of twenty signals; the probable error of each value works out about ·002 sec. or ·003 sec. The values of $\frac{t_{ew} - t_{we}}{2}$, *i.e.*, the effects on a longitude determination (see equation 16), range from ·026 sec. to − ·015 sec., an amount by no means desirable in a primary longitude.

This appeared to be conclusive proof of the variations in transmission time, due to adjustment, which are liable to occur in actual practice; though the matter might have been left here, another experiment was performed, designed to test the effects of variations in current strength in line and local circuits; in addition to the direct information obtained, this would furnish an independent test of the reliability of transmission times measured in this way, since according to theory the latter should vary regularly, if at all, with the changes in current strength. An attempt was also made to separate the armature-times of the line relays from the time of transmission through the repeaters; though this attempt failed in the first instance, the results are given, as affording a practical example of the errors liable to be introduced into the measurement of short intervals of time, unless due precautions are taken. The first column in Table I. gives the line current, the second the voltage of the local circuit; under E. and W. are the transmission times east and west, measured as before. The last column gives the values obtained for the *difference* in the armature-times of the line relays, in the sense $\delta t_e - \delta t_w$; they were obtained by breaking the common circuit of L_1 and L_2 at V by means of a key (see Fig. 5), and measuring the difference of the clock-times of the signals recorded by L_1 and L_2 as before; apparently, at first sight, this should give the quantity required. Now evidently, if t_{we} and t_{ew} represent the actual times of transmission through the repeaters, $t_{we} = E - (\delta t_e - \delta t_w)$ and $t_{ew} = W + (\delta t_e - \delta t_w)$. On attempting, however to apply this correction, we are confronted with impossible negative values of t_{we}.

TABLE I. TIME OF TRANSMISSION OF SIGNALS THROUGH REPEATERS.

Line Current.	Local Voltage.	E.	W.	$\delta t_e - \delta t_w$.
·017 amp.	3·6	·031 sec.	·026 sec.	·016 sec.
·032 "	3·6	·042 "	·029 "	·041 "
·048 "	3·6	·044 "	·030 "	·064 "
·064 "	3·6	·043 "	·036 "	·073 "
·064 "	5·6	·050 "	·039 "	
·064 "	7·6	·050 "	·041 "	
·064 "	9·6	·050 "	·041 "	

For some time this was very puzzling and discouraging, as tending to throw doubt on the whole series of experiments, but the phenomenon is capable of a simple explanation as follows. The line relays L_1 and L_2 were not identical; L_1 (the western one) was of the type used as a signal relay in longitude operations, with split tubular cores; L_2 had the ordinary solid cores; consequently, L_2 had much the higher coefficient of self-induction. Now the two relays were still connected in parallel even after the opening of the circuit at V; the higher self-induction of L_2 (as might indeed have been foreseen) simply tended to establish a circuit through itself and L_1, thus quickening the action of L_1 and retarding its own, *i.e.*, making the measured value of $\delta t_e - \delta t_w$ too large. That such action is possible is proved conclusively by a piece of independent evidence which presented itself in actual work in connection with the time service. Three identical differentially wound polar relays were connected in parallel; in the case of two of them the current passed through both windings in series, in that of the third through only one; thus the value of the self-induction in the third was lower than in either of the others; this third relay was neutrally adjusted, *i.e.*, the armature would stay indifferently in either position when no current flowed, a *reversal* of current being necessary to operate it. Yet it was consistently operated by the simple breaking of the circuit, thus proving conclusively that the current passing through it not only died down more rapidly than it otherwise would, but was actually reversed.

These facts are of importance as serving to emphasize the care necessary in the use of divided circuits when used for the exact measurement of time; in particular, they indicate that chronographs should not be operated in parallel unless their windings are identical; rather they should be worked by separate relays (a separate battery is not, however, necessary); moreover, the relays, if operated by the same clock, should be identical.

The experiment with the repeaters was repeated in a slightly different form, to avoid the above error; in this case the armature-times of the line relays were eliminated during the measurement by interchanging them; half the signals were sent with L_1 connected to R_1 and L_2 to R_2, the other half with L_2 connected to R_1 and L_1 to R_2; the range of current-strengths was also different. The results are shown in Table II.; the columns headed E and W are in this case the transmission times through the repeaters, freed from effect of the line relays. While of course not perfectly regular, they are sufficiently so to indicate the general law; with the exception of the values in the fourth line, which appear to be somewhat too small, they form an unbroken series increasing and decreasing again with the line current, while the times with the heavier local current are in each case, with the above

TABLE II. TIME OF TRANSMISSION OF SIGNALS THROUGH REPEATERS.

Line Current.	Local Voltage.	E.	W.
·017 amp.	5·0	·032 sec.	·022 sec.
·043 "	5·0	·049 "	·037 "
·086 "	5·0	·055 "	·040 "
·086 "	10·8	·051 "	·044 "
·044 "	10·8	·056 "	·044 "
·017 "	10·8	·043 "	·025 "

exception, slightly greater than the corresponding ones where it had the lower value; it may be noted in addition, that the values under E are consistently greater than those under W. The same general tendencies may be observed in Table I., though not in as regular a degree; this is due probably to the fact that each value in Table I. is derived from only twenty signals, as against forty in Table II.; the inclusion of the armature-times of the line relays in Table I. should make no difference in the *general* tendency, as the quantities follow similar laws.

The conclusion to be drawn from these experiments appears to be that the time of transmission through repeaters in opposite directions may vary within comparatively wide limits, being affected both by conditions of adjustment and by current strength. The effect of the first of these causes on longitude measurements may of course be eliminated by reversal of the repeaters without change of adjustment during the progress of the exchange, but with the differences of current strength in the two sections of the line this is not the case, the latter being dependent on length and condition of line, &c. In fact it is conceivable that under certain conditions—*e.g.*, a large difference of current strength in the two sections of the line, with a *corresponding* perfect adjustment of repeaters—the reversal of the repeaters without readjustment might only aggravate matters—might indeed introduce an error where otherwise none would have occurred. One thing is certain; repeaters should never be used in primary longitude work except in case of absolute necessity. In that case it would probably be best to increase the number of exchanges, even having several in immediate succession, and to insist on a complete and independent readjustment of all repeaters between exchanges, trusting to the principle of compensation of errors in the final result; under such conditions it would at least be reasonably certain that the result would not be affected by systematic error.

There still remains to be considered the possible difference in armature-times of the signal relays at the two stations, the quantity $\delta t_w - \delta t_e$ in equation (16), which enters for its full value into the longitude. Most of the signal relays on our longitude switch-boards are of the split-core type described above, having a resistance of about 330 ohms; one, however, is a polar relay, resistance 400 ohms in each winding. The armature-times of both these types were measured under different conditions of current and adjustment; the method of measurement was as follows. A relay with two pairs of points was controlled by the signal key; one pair of points recorded directly on one side of the chronograph, the other pair worked the relay whose armature-time was to be measured; the points of the latter recorded on the other side of the chronograph. To eliminate the individuality of the separate pairs of points of the first relay, their connections were interchanged during each measurement, as well as those of the two coils of the chronograph. Each measurement consisted of ten signals with each system of connection, or forty in all.

Table III. shows the effect on the split-core relay of independent variations of the three variable quantities, current, armature-tension, and distance of coils from armature; in only one case, one which can easily be guarded against in actual work, was the armature-time greater than ·005 sec., while it did not reach even that value

TABLE III. ARMATURE-TIME OF SPLIT-CORE RELAY.

Current.	Adjustment.		Arm.-time.
	Coils.	Tension.	
·058 amp.	Close.	Loose.	·012 sec.
·058 "	Medium.	"	·001 "
·058 "	Distant.	"	·005 "
·058 "	Medium.	"	·005 "
·058 "	"	Medium.	·003 "
·058 "	"	Tight.	·0005 "
·029 "	"	Medium.	·002 "
·058 "	"	"	·0025 "
·117 "	"	"	·003 "

except when the tension was loose. This indicates that the relay with split tubular cores is reasonably efficient for longitude work, and may be rendered very highly so by care in keeping the adjustment keyed up to the highest point at which the relay will work. This fact renders practically unnecessary the complex balancing system often employed in longitude exchanges in Europe.

TABLE IV. ARMATURE-TIME OF POLAR RELAY.

Current.	Adjustment.		Arm.-time.	Remarks.
	Pole-piece.	Tension.		
·005 amp.	Close.	Loose.	·029 sec.	One winding.
·005 "	"	Tight.	·002 "	"
·005 "	Distant.	Loose.	·027 "	"
·005 "	"	Tight.	·006 "	"
·025 "			·025 "	Both windings.
·050 "			·056 "	One winding, other short-circuited.
·050 "			·021 "	One winding.
·025 "			·012 "	"
·012 "			·009 "	"
·005 "			·002 "	"
·005 "			·008 "	" other short-circuited.
·0025 "			·003 "	Both windings.

Table IV. shows the armature-times for the polar relay under similar conditions. In these relays the armature moves between two pole-pieces which form the permanent field; the distance between the pole-pieces is variable; this is the adjustment referred to in the second column; the 'tension,' in this case the effect of the permanent magnetic field, depends on the position of the armature relative to the pole-pieces. As will be seen from the table, the adjustment of the pole-pieces makes little difference, while the effect of variation of tension is very considerable; variations of current also produce a considerable effect. If both windings are used in series the armature-time appears to be slightly greater (for the same adjustment) than if only one winding is used, with the same number of ampere-turns; on the other hand, if the current be passed through one winding, and the other short-circuited, the armature-time is more than doubled. On the whole, though under the most favourable conditions the armature-time is fairly small, this type of relay is decidedly unsuitable for the measurement of short intervals of time, and should never be used in longitude operations or for working chronographs except in extremity.

ERRORS OF TRANSIT OBSERVATIONS.

The experiments described below were undertaken in the first instance merely as a test of the relative merits of the transit key and the travelling wire micrometer as methods of observing transits; the results which developed, however, served to call attention to some other phases of the question which seemed to call for investigation. That work is as yet by no means complete; still, some results have been arrived at which serve to show in a general way the causes underlying some of the larger errors in transit work, and to indicate the lines along which further investigation may most profitably be carried on. It should be premised that what follows refers only to observations with a portable instrument, that is, to the case in which the azimuth and collimation errors of the instrument must be determined from the observations themselves, and not by means of a fixed azimuth mark and collimating telescopes. For a more complete understanding of the conditions, it may be well to explain in a few words the general method of making the observations and reductions which has been customary here. It is to be noted also that the purpose of the regular observations is the determination of clock-error.

The instruments used are the ordinary reversible type of Cooke transit, with object-glass of about three inches aperture and three feet focal length. These instruments, though portable, are heavy and massive enough to be fairly stable during an evening's work. A complete time determination consists usually of the transits of twelve stars, six in each position of the instrument; of these six, one is a slow-moving north star for the determination of azimuth, while the remaining five are south of the zenith. After applying corrections for level error and for diurnal aberration, we have from each star an equation of the form $Cc + Aa + \Delta T = l$, where c and a are the collimation and azimuth errors respectively, $C = \sec \delta$, $A = \sin (\phi - \delta) \sec \delta$, and $\triangle T$ is the clock correction. The twelve equations are combined by least squares, giving equal weights to the separate observations, and hence are deduced the values of c, a, and $\triangle T$. The probable error of the resulting $\triangle T$ is found in the usual way from the residuals given by the separate stars. It has been the usual custom to so select the stars as to 'balance', the set, that is, to have ΣA and ΣC each as nearly zero as convenient.

Every one who has had extended experience with such observations has noticed certain discrepancies which frequently show themselves in the results. In an extended series of observations for personal equation, the different values obtained, even from two determinations on the same night, may sometimes, if not frequently, differ by a tenth of a second or even more, while the probable errors of the individual sets may not in any case exceed one one-hundredth of a second. Nor is it only in personal equation observations that these discrepancies show themselves; in longitude determinations, a fair average of the extreme difference obtained during a few night's work would probably be about a tenth of a second or more; and the differences in clock-error obtained by the same observer on the same night from successive determinations, even when using a reliable clock, are often of about the same order of magnitude.

From a comparison of the magnitude of these frequent discrepancies with that of the corresponding probable errors, and from the fact that they do not follow the same law, and seem to have no connection, it is at once evident that the discrepancies are not the result of truly accidental errors, but are systematic in their nature; that is to say, that of two sets taken on the same night, one may be affected by a certain systematic error, the other by a different error also systematic. The simplest explanation of this fact, and the one which has been generally accepted,* is that these discrepancies are the result of real variations in the observer's personal equation. Indeed it seems à priori quite probable that a quantity so purely a personal one would depend on the observer's physical and mental state, and would consequently vary from night to night, and even during the same night. Such a supposition would fully and absolutely explain the observed facts; for even though the change were a gradual and regular one during any single night it would not be evident from a consideration of the separate observations, for the reason that the grouping into sets and the separate reduction of these would tend to mask its progressive character. And further, if the discrepancies were due to this cause, we should naturally expect that in observations with the travelling wire micrometer, which are comparatively free from personal error, they would disappear or at least be considerably reduced. It remained, then, only to test this hypothesis by actual experiment.

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* See "Test of a Transit Micrometer", U.S. Coast and Geodetic Survey report, 1904; also "Die Beobachtungsmethode mittelst des Repsold'shen Registrirmikrometer in ihre Anwendung auf Längenbestimmungen," by Prof. Th. Albrecht, in Astronomische Nachrichten, No. 3699, Band 155.

Two of the instruments belonging to the Observatory have been equipped with the micrometer attachment for a couple of seasons; but most of the observations taken with them were in the field, and the variations in the rates of the chronometers used made it impossible to place any dependence on conclusions drawn from these data. There remain some observations for personal equation taken here by Mr. McDiarmid, using the Riefler Sidereal clock, which might have been compared with observations taken by myself at the same time with the key. But any conclusions based on these data could scarcely have been final, for whichever way the balance went, the possibility would remain of explaining it by the superior accuracy of one or the other observer. Consequently it was decided to make a test by conducting a series of observations with two instruments, one fitted with a transit micrometer, the other with a fixed field and a key. The method followed was to take as many time sets as convenient, four if possible, on the same night, with the key and micrometer alternately, repeating the programme on a sufficient number of nights. The accurate running of the Riefler clock made it possible to compare rigorously the results of all the observations on any night, and even, with some slight reservation, on succeeding nights.

Up to that time I had never used the transit micrometer, so that in the first place it was necessary to gain some experience in its use. It was decided, however, to so arrange the observations made for that purpose that they could be made use of to obtain some preliminary results. The observations were begun about the first of November last; only six stars were observed in each set instead of twelve, and four sets were taken on each clear night for six nights, making in all twelve sets with each instrument. The continuity of the series was broken at this point by a period of cloudy weather, and the later observations were confined to the gaining of experience with the micrometer. The indications given by these six nights' observations were not very conclusive; while the average inter-agreement of the observations for the whole period was about the same for key and micrometer, the result given by discarding one night's observations was quite decidedly in favour of the micrometer; considering the fact of my inexperience with the latter, it was perhaps natural that I should be confirmed in my former belief that the discrepancies in key observations were explainable on the assumption of variations in personal equation, and would tend to disappear in micrometer work. At the same time, it was of course realized that time-sets of only six stars were rather unreliable, and that the data were not extensive enough to warrant definite conclusions. It was decided, therefore, after having gained some experience in micrometer observations, to proceed with a new and more extended test, and to observe full sets of twelve stars in each case.

This series of observations was begun about the middle of December, and concluded early in February; during that time some forty-five sets had been observed on sixteen different nights, nearly an equal number with each instrument. It was not possible, on account of weather conditions, to adhere throughout to the full program of four sets on every night; sometimes only three or two were obtained, and on a few occasions only one. It was hoped, however, that even these might be made some use of, if the clock-rate proved constant enough from day to day. The results are shown in Table V. The second and third columns show respectively the clock corrections (in seconds) and their probable errors as deduced in the usual way; the fourth and fifth columns contain the discordances between the different observations on the same night with the same instrument. These range in the case of the key up to ·129 sec., with an average of ·049 sec.; in that of the micrometer to ·103 sec., with an average of ·045 sec.; the average probable error is ·011 sec. for each instrument. It is worthy of note that on December 17th, when the largest discrepancy with the micrometer occurred, the probable errors of the two sets were only ·009 sec. and ·011 sec., while the discrepancy of ·129 sec. with the key occurred between two sets whose probable errors were ·007 sec. and ·011 sec.

TABLE V.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Date	△T	r	Discordances. Key	Discordances. Microm.	△T.	Mean for night.	△T at mean rate.	Resid. for night	Residuals. Key	Residuals. Microm.
Dec. 17 ...	–2·704	·009			–2·704					–·059
" 17...	–3·070*	·011	·024	·103	–2·625*	–2·645	–2·645	·000	·020	
" 17...	–3·094*	·012			–2·649*				–·004	
" 17....	–2·601	·011			–2·601					·044
" 19 ...	–2·612	·013			–2 612					·047
" 19....	–3·182*	·011	·129	·068	–2·737*	–2·659	–2·659	·000	–·078	
" 19....	–3·053*	·007			–2·608*				·051	
" 19....	–2·680	·011			–2·680					–·021
" 27 ...	–3·165*	·012			–2·720*	–2·720	–2·719	–·001	–·001	
Jan. 2 ...	–3·211*	·010			–2·766*	–2·766	–2·763	–·003	–·003	
" 6....	–2·746	·009			–2·746	–2·791	–2·793	·002		·047
" 6...	–3·281*	·004			–2·836*				–·043	
" 9....	–2·803	·015			–2·803					·012
" 9....	–3·221*	·015	·015	·017	–2·776*	–2·797	–2·815	·018	·039	
" 9....	–3·236*	·015			–2·791*				·024	
" 9...	–2·820	·014			–2·820					–·005
" 11....	–2·856	·007			–2·856					–·026
" 11....	–3·308*	·007	·046		–2·863*	–2·845	–2·830	–·015	–·033	
" 11....	–3·262*	·012			–2·817*				·013	
" 15....	–2·721	·008			–2·721	–2·691	–2·684	–·007		–037
" 15....	–3·107*	·009			–2·662*				·022	
" 16...	–2 617	013			–2·617	–2·617	–2·647	·030		·030
" 18....	–2·562	·013			–2·562	–2·562	–2 573	·011		·011
" 21 ...	–2·508	·010			–2·508					–·046
" 21....	–2·899*	·009	·063		–2·454*	–2·493	–2·462	–·031	·008	
" 21....	–2·962*	.009			–2·517*				–·055	
" 23...	–2·778*	·013			–2·333*				·055	
" 23 ...	–2·409	·012	·034	·007	–2·409	–2·378	–2·388	·010		–·021
" 23...	–2·402	·015			–2·402					–·014
" 23...	–2·812*	·012			–2·367*				·021	
" 28....	–2·214	·020			–2·214	–2·205	–2·204	–·001		–·010
" 28 ...	–2·641*	·013			–2·196*				·008	
" 30....	–2·452*	·008			–2·007*					
" 30...	–2·044	·007	·040	·066	–2·044	–2·019				
" 30....	–1·978	·011			–1·978					
" 30....	–2·492*	·010			–2·047*					
Feb. 4....	–1 515	·011			–1·515					
" 4 ...	–1·967*	·013	·064		–1·522*	–1·541				
" 4...	–2·051*	·011			–1·586*					
" 6....	–1·670*	·008			–1·225*					
" 6....	–1·169	·007	·008	·011	–1·169	–1·198				
" 6....	–1·180	·012			–1·180					
" 6....	–1 662*	·014			–1·217*					
Means..		·011* ·011	·049	·045					·028	·029

*Key observations.

We may examine this series of observations in another way, which will give perhaps a better comparison of the performances of the two instruments. It has been mentioned that the standard clock of the Observatory has a very steady rate; if it should so happen that the series of observations with one instrument showed a pronounced tendency to agree more closely with the supposition of a regular rate-curve, that would indicate, other things being equal, that that series of observations was less affected by fluctuating errors. From the values in column II. we can obtain the mean systematic difference between the key and micrometer observations, a quantity which of course corresponds to personal equation; it amounts to ·445 sec. The application of this correction to the key observations makes all the observations on any single night strictly comparable; the derived values are given in column VI., and the means for each night in column VII.

From a consideration of these it is apparent that as regards clock-rate the whole period falls naturally into three parts, during the first two of which at least the rate was very nearly constant. The irregularity during the last few days is no doubt due to the fact that the outside case of the clock was then being installed, which, in addition to a certain amount of direct disturbance, probably gave rise to considerable irregular changes of temperature. The decided change in rate at January 11th is somewhat puzzling; it may be partially accounted for by changes in local temperature, as about that time, on account of the extreme coldness of the weather, the electric heater proved just insufficient to keep the temperature up to its former value, and several incandescent lamps were left burning continually in the clock room to help turn the scale; a slight increase in temperature (though only about ·2° C) was indicated by the thermometer in the upper part of the clock, and it is possible that the change in distribution of the heating may have induced a larger difference in the temperature of the pendulum, though this seems doubtful. On the other hand, there was exactly at that date a small but very definite change in the amplitude of swing of the pendulum, which was read daily; for the month immediately preceding, the amplitude varied between 91·6′ and 92·1′, the average being 91·9′; from January 11th till the end of the month it varied between 91·2′ and 91·6′, the average being 91·3′; this can have no connection with temperature, as the monthly averages for the three preceding months had been respectively 91·8′, 91·7′ and 91·7′, while the average temperatures were 25·8°, 25·1° and 23·5°. Whatever the cause of the simultaneous change in amplitude and rate, there is little doubt that they were closely connected.

However that may be, it is sufficient for the purpose of our comparison that during each of the first two periods the evidence points to a practically constant rate, so that up to January 28th we are enabled to make a comparison of all the observations without regard to date. During the first period (December 17th to January 11th) the mean rate was − ·0074 sec. per day; during the second (January 11th to January 28th), + ·0359 sec. per day. The theoretical clock corrections at these constant rates are given in column VIII., while column IX. exhibits the differences between columns VII. and VIII. The smallness of these differences at once gives colour to the supposition that the rate was practically uniform during each period, and allows us without fear of error to make use of the test above referred to. This consists in a comparison of the residuals of each separate observation from the assumed rate-curve; these are tabulated for the two instruments in columns X. and XI. The mean value for the key is ·028 sec., and for the micrometer ·029 sec., the largest values being ·078 sec. and ·059 sec. respectively. Or if we treat these quantities as real residuals, and determine from them in the usual way the probable error of a single observation, we get ·025 sec. in the case of the key, and ·024 sec. in that of the micrometer.

This series of observations, then, in whatever way we examine it, points to the conclusion that so far as irregular variations are concerned there is very little to choose between the key and the micrometer. True, the values are on the whole perhaps slightly smaller in the case of the micrometer, but the difference is so slight that we would not be justified in drawing any conclusions from it.

In order to check the conclusions arrived at, an investigation was made of all the available micrometer observations made at the Observatory; those taken in the field were useless for the purpose, as stated before, on account of the inaccuracies of chronometer rate. The entire data were found to consist of thirteen nights' work, on each of which two time sets had been taken. These nights were distributed over several months; the largest discrepancy which occurred was ·108 sec., the average value being ·035 sec., while the average of the probable errors of all the sets was ·010 sec. From fifteen nights' key observations taken during the same period the largest discrepancy was ·101 sec., the average being ·034 sec., and the average probable error ·010 sec. In this case the discrepancies are somewhat smaller than those obtained in December and January, as was of course to be expected from the difference in temperature and the consequent difference of comfort in making the observations. As in the former case, however, the values are practically the same for the two methods of observing.

The conclusion, then, would appear to be forced upon us, that if irregular fluctuations of personal error do occur in key observations, their influence is effectually masked by some other source or sources of error which are common to observations with the transit micrometer. This is, so far as I am aware, the first comparative test of the kind to be made under identical conditions for both instruments, and it is perhaps not surprising that what seems to have been an erroneous assumption should have received general acceptance; indeed, the present investigation was undertaken in the first place with the firm expectation of merely confirming the generally accepted opinion. These conclusions, however, it must be remembered, do not invalidate the claim for the micrometer of the practical elimination of personal equation and all the advantages thereby entailed.

Taking it for granted, then, that these effects are practically independent of the instrument used, and therefore not due to variations of personal equation, it becomes legitimate, in order to obtain more extensive data on the real magnitude of the variations, to take into account any additional key observations available. These consist of about fifty nights' work, on each of which at least two time determinations were taken; the average value of the discordances amounts to ·039 sec., the average of the probable errors being ·012 sec. Combining these with the observations already considered, both with key and micrometer, we obtain, as the average discordance from nearly a hundred nights' work, the quantity ·039 sec., the average probable error corresponding being ·011 sec. An idea of the magnitude of the real probable error to which such an average discordance corresponds may be obtained from the values derived from columns X. and XI. in Table V., and also from the personal equation observations made by Mr. McDiarmid and myself. These last consist of between twenty and thirty separate determinations; the probable error of a single determination, computed by the residuals from the mean, amounts to ·038 sec. Now this is evidently the probable error of the *difference* of two time sets; that of a single one would therefore be ·027 sec. The average discordance on the same night during these observations was ·035 sec. Combining this with the probable error of ·024 sec. or ·025 sec. from Table V. and the corresponding discordances, we may assume as a rough average that the final mean discordance of ·039 sec. corresponds to a real 'probable error' of about ·025 sec. That is to say, the real liability to error exceeds more than two-fold the nominal value obtained in the usual way from the residuals of the separate stars.

It must be admitted, of course, that to such a limited number of observations as the twelve stars of a time set, the theory of the probability of errors does not rigorously apply; for this reason it is to be expected that the probable error obtained from the application of this principle should be systematically too small; and it might easily happen that in some cases it would be vastly so. But in the average of a large number of observations, such as is here considered, it seems impossible to account for effects of the observed magnitude by any such hypothesis. To account for at least a part of the discrepancy, we must rather look for some source of error which from its nature would not show itself in the residuals, which might systematically affect the result of a complete set by a considerable quantity, and which might vary from one set to another.

In considering the question à priori, the explanation seemed most likely to lie in defective determinations of azimuth caused by errors in the observations of polar stars; this view was strengthened by the reflection that when the azimuths of the two 'clamps' of a time set are reduced separately, they frequently differ by a considerable amount. A simple test of the validity of this explanation can be obtained by observing in the course of a set as large a number of polar stars as possible, and examining the effect of a choice of different ones in reduction. Table VI. shows the

TABLE VI.

Date	T	a	r	Difference
Dec. 19	−2·654	− ·060	·016	·073
	−2·581	− ·196	·013	
Dec. 19*	−3·182	·485	·012	·069
	−3·113	·360	·016	
Feb. 21	·122	− ·244	·008	·013
	·135	− ·264	·008	
Mar. 6	·698	·317	·010	·046
	·744	·244	·014	
Mar. 25	− ·655	− ·349	·019	·018
	− ·637	− ·398	·017	

* Key observations.

result of such observations and reductions on several nights. In most cases four polars and ten time stars were observed in each set; the polars were in every case ones that might have been used in the course of ordinary observations—*i.e.*, ranging from about 75° to 85° declination. The reduction was made first with one pair of polars, omitting the others, and afterwards with another pair and the *same* time stars. The second and third columns give the clock corrections and azimuths obtained in this way from each set, the fourth column containing the probable errors of the corresponding clock corrections. In the last column is given the difference between the two time determinations from each set. It will be seen that in three cases out of the five the two values of the azimuth differ by a considerable amount, while in the same three cases the resulting effect on the time determination is about ·05 sec. or over. In some cases almost as large a change would have resulted by replacing only one of the polars, though in the majority of cases each separate polar gives a quite distinct value of the azimuth.

There can be no doubt that we have here the principal source of error in such observations as we have been considering. While in itself it may not be of sufficient magnitude to completely account for all the discrepancies observed, it would seem to do so fully when taken in conjunction with ordinary accidental errors of observation and with the errors arising from defective level readings, which, however, it greatly overshadows in magnitude. The fault does not appear to lie, at least in the main, in catalogue errors or in magnitude equation, but simply in accidental errors of observations of the polar stars, which of course become systematic with respect to any one set. It remains to be seen whether any method of observing can be devised to overcome the difficulty. Some tentative experiments have been made to this end, but the investigation is not yet complete. An account of these experiments, together with a discussion of the theoretical conditions, is reserved for a future report.

RISING AND SETTING OF THE SUN AT OTTAWA.

The tables given below for the rising and setting of the sun at Ottawa for 1907 were computed by W. M. Tobey, and have been checked over carefully by both Mr. Tobey and myself. The exact formulae for rising and setting (in standard civil time) are respectively:—

$$T_R = 12^h\ 02^m\ 52^s + e_1 - t_1$$
$$T_S = 0^h\ 02^m\ 52^s + e_2 + t_2$$

where e = equation of time for corresponding epoch

$$\sin \tfrac{1}{2}\ t = \sqrt{\frac{\sin \frac{1}{2}\ (\zeta + \phi - \delta)\ \sin \frac{1}{2}\ (\zeta - \phi + \delta)}{\cos \phi\ \cos \delta}}$$

$\zeta = 90°$ + horizontal refraction + sun's semi-diameter.

ϕ = latitude.

δ = sun's apparent declination for corresponding epoch.

The values adopted for the horizontal refraction and semi-diameter were 33′ and 16′ respectively, giving $\zeta = 90°\ 49'$; the latitude was taken to the nearest minute (45° 24′). For convenience in computation, the values used for e and δ were those corresponding to 6 a.m. and 6 p.m., respectively; this introduces a small variable error, whose maximum value, however, does not exceed four or five seconds, and is negligible in comparison with the uncertainties of refraction.

The object of carrying the computation to seconds was that the tables might be of permanent value, since tables for any ensuing year can be formed from them by interpolation. For since the length of the tropical year is 365·24221 days, and the length of the civil year 365 days or 366 days, 1908, 1912, &c., being leap years, it follows that if T_{1907} be the time of rising or setting on any particular day, and $\triangle T$ the difference between that day and the next (or preceding), we will have

$$T_{1907+n} = T_{1907} + K \triangle T$$

where $K = -\ \cdot 24221\ n$ + the greatest integer in $\dfrac{n+2}{4}$.

It is to be noted, however, that in a leap year this value of K applies in January and February only, and must be increased by unity for the remaining months. The values of K are given for the next few years:—

1908	− ·242 ·758
1909	·516
1910	·273
1911	·031
1912	− ·211 ·789
1913	·547
1914	·305
1915	·062

Date.	January.						February.						March.						April.						Date.
	Rising.			Setting.			Rising.			Setting.			Rising.			Setting.			Rising.			Setting.			
1907	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	1907
1	7	42	59	4	29	46	7	25	18	5	08	27	6	43	18	5	48	32	5	45	23	6	29	28	1
2	7	43	03	4	30	40	7	24	08	5	09	54	6	41	32	5	49	54	5	43	30	6	30	45	2
3	7	43	04	4	31	36	7	22	55	5	11	21	6	39	45	5	51	17	5	41	37	6	32	02	3
4	7	43	02	4	32	34	7	21	42	5	12	48	6	37	58	5	52	39	5	39	44	6	33	19	4
5	7	42	57	4	33	35	7	20	25	5	14	15	6	36	10	5	54	01	5	37	53	6	34	36	5
6	7	42	51	4	34	36	7	19	09	5	15	42	6	34	21	5	55	22	5	36	00	6	35	53	6
7	7	42	41	4	35	39	7	17	50	5	17	09	6	32	32	5	56	43	5	34	08	6	37	10	7
8	7	42	29	4	36	45	7	16	30	5	18	37	6	30	42	5	58	03	5	32	17	6	38	25	8
9	7	42	14	4	37	52	7	15	07	5	20	04	6	28	51	5	59	25	5	30	26	6	39	43	9
10	7	41	56	4	39	01	7	13	44	5	21	31	6	27	01	6	00	45	5	28	36	6	41	01	10
11	7	41	36	4	40	11	7	12	19	5	22	59	6	25	09	6	02	06	5	26	46	6	42	17	11
12	7	41	13	4	41	23	7	10	53	5	24	26	6	23	18	6	03	26	5	24	57	6	43	34	12
13	7	40	48	4	42	35	7	09	25	5	25	53	6	21	26	6	04	45	5	23	08	6	44	51	13
14	7	40	20	4	43	48	7	07	56	5	27	20	6	19	33	6	06	05	5	21	20	6	46	08	14
15	7	39	50	4	45	04	7	06	25	5	28	46	6	17	41	6	07	25	5	19	33	6	47	26	15
16	7	39	17	4	46	21	7	04	53	5	30	12	6	15	48	6	08	44	5	17	46	6	48	42	16
17	7	38	41	4	47	38	7	03	20	5	31	38	6	13	54	6	10	03	5	16	00	6	49	59	17
18	7	38	04	4	48	56	7	01	45	5	33	05	6	12	01	6	11	21	5	14	15	6	51	16	18
19	7	37	24	4	50	16	7	00	10	5	34	30	6	10	07	6	12	40	5	12	31	6	52	32	19
20	7	36	41	4	51	36	6	58	33	5	35	56	6	08	13	6	13	58	5	10	47	6	53	49	20
21	7	35	56	4	52	58	6	56	55	5	37	21	6	06	19	6	15	16	5	09	04	6	55	06	21
22	7	35	09	4	54	19	6	55	17	5	38	46	6	04	25	6	16	35	5	07	22	6	56	23	22
23	7	34	20	4	55	42	6	53	37	5	40	11	6	02	30	6	17	53	5	05	41	6	57	40	23
24	7	33	28	4	57	05	6	51	57	5	41	35	6	00	36	6	19	10	5	04	01	6	58	55	24
25	7	32	35	4	58	29	6	50	14	5	42	59	5	58	41	6	20	28	5	02	22	7	00	13	25
26	7	31	37	4	59	53	6	48	31	5	44	22	5	56	47	6	21	45	5	00	44	7	01	28	26
27	7	30	39	5	01	18	6	46	47	5	45	46	5	54	53	6	23	03	4	59	07	7	02	44	27
28	7	29	39	5	02	43	6	45	03	5	47	09	5	52	58	6	24	20	4	57	31	7	04	00	28
29	7	28	35	5	04	09	...	...	...	...	...	...	5	51	05	6	25	37	4	55	57	7	05	18	29
30	7	27	31	5	05	34	...	...	...	...	...	...	5	49	11	6	26	54	4	54	23	7	06	32	30
31	7	26	26	5	07	00	...	...	...	...	...	...	5	47	17	6	28	11	...	...	...	...	...	...	31

Date.	May. Rising.			May. Setting.			June. Rising.			June. Setting.			July. Rising.			July. Setting.			August. Rising.			August. Setting.			Date.
1907	H.	M.	S.	H,	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	1907
1	4	52	50	7	07	47	4	18	24	7	42	39	4	17	39	7	54	47	4	45	36	7	31	52	1
2	4	51	19	7	09	03	4	17	49	7	43	31	4	18	11	7	54	36	4	46	46	7	30	36	2
3	4	49	49	7	10	19	4	17	16	7	44	22	4	18	45	7	54	23	4	47	55	7	29	18	3
4	4	48	21	7	11	33	4	16	45	7	45	11	4	19	22	7	54	08	4	49	05	7	27	58	4
5	4	46	54	7	12	50	4	16	17	7	45	59	4	20	00	7	53	51	4	50	15	7	26	37	5
6	4	45	29	7	14	05	4	15	51	7	46	44	4	20	40	7	53	31	4	51	27	7	25	14	6
7	4	44	03	7	15	17	4	15	27	7	47	28	4	21	22	7	53	09	4	52	37	7	23	50	7
8	4	42	41	7	16	31	4	15	06	7	48	10	4	22	05	7	52	45	4	53	50	7	22	25	8
9	4	41	20	7	17	45	4	14	48	7	48	50	4	22	50	7	52	17	4	55	01	7	20	57	9
10	4	40	00	7	18	58	4	14	32	7	49	28	4	23	37	7	51	48	4	56	12	7	19	29	10
11	4	38	41	7	20	11	4	14	18	7	50	05	4	24	25	7	51	16	4	57	25	7	17	59	11
12	4	37	25	7	21	22	4	14	06	7	50	41	4	25	15	7	50	41	4	58	38	7	16	27	12
13	4	36	10	7	22	35	4	13	56	7	51	14	4	26	06	7	50	05	4	59	50	7	14	55	13
14	4	34	57	7	23	46	4	13	49	7	51	44	4	26	58	7	49	27	5	01	02	7	13	23	14
15	4	33	45	7	24	56	4	13	46	7	52	13	4	27	51	7	48	46	5	02	14	7	11	46	15
16	4	32	36	7	26	06	4	13	42	7	52	39	4	28	46	7	48	03	5	03	28	7	10	11	16
17	4	31	27	7	27	15	4	13	41	7	53	05	4	29	42	7	47	18	5	04	40	7	08	33	17
18	4	30	21	7	28	24	4	13	45	7	53	28	4	30	40	7	46	29	5	05	53	7	06	55	18
19	4	29	16	7	29	33	4	13	50	7	53	47	4	31	39	7	45	40	5	07	06	7	05	15	19
20	4	28	15	7	30	38	4	13	56	7	54	05	4	32	38	7	44	49	5	08	19	7	03	35	20
21	4	27	14	7	31	45	4	14	06	7	54	20	4	33	38	7	43	55	5	09	31	7	01	53	21
22	4	26	15	7	32	50	4	14	17	7	54	33	4	34	39	7	42	59	5	10	45	7	00	11	22
23	4	25	18	7	33	54	4	14	31	7	54	44	4	35	42	7	12	00	5	11	58	6	58	27	23
24	4	24	24	7	34	57	4	14	47	7	54	53	4	36	45	7	41	00	5	13	11	6	56	43	24
25	4	23	31	7	35	59	4	15	05	7	54	59	4	37	49	7	39	58	5	14	24	6	54	58	25
26	4	22	41	7	36	59	4	15	25	7	55	03	4	38	53	7	38	55	5	15	37	6	53	12	26
27	4	21	53	7	37	59	4	15	48	7	55	05	4	39	59	7	37	49	5	16	50	6	51	26	27
28	4	21	06	7	38	58	4	16	12	7	55	04	4	41	06	7	36	41	5	18	03	6	49	38	28
29	4	20	22	7	39	56	4	16	39	7	55	00	4	42	13	7	35	31	5	19	16	6	47	50	29
30	4	19	40	7	40	52	4	17	08	7	54	55	4	43	20	7	34	20	5	20	29	6	46	01	30
31	4	19	01	7	41	46	...	...	...	...	...	...	4	44	27	7	33	07	5	21	42	6	14	12	31

Date.	September.						October.						November.						December.						Date.
	Rising.			Setting.			Rising.			Setting.			Rising.			Setting.			Rising.			Setting.			
1907	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	H.	M.	S.	1907
1	5	22	55	6	42	21	5	59	41	5	45	06	6	40	49	4	51	34	7	21	15	4	21	48	1
2	5	24	08	6	40	32	6	00	56	5	43	12	6	42	14	4	50	07	7	22	25	4	21	24	2
3	5	25	21	6	38	40	6	02	12	5	41	19	6	43	37	4	48	42	7	23	34	4	21	02	3
4	5	26	34	6	36	49	6	03	28	5	39	26	6	45	01	4	47	18	7	24	42	4	20	43	4
5	5	27	47	6	34	56	6	04	44	5	37	33	6	46	26	4	45	56	7	25	48	4	20	26	5
6	5	29	00	6	33	04	6	06	01	5	35	41	6	47	50	4	44	36	7	26	53	4	20	12	6
7	5	30	13	6	31	11	6	07	18	5	33	49	6	49	14	4	43	17	7	27	56	4	20	01	7
8	5	31	26	6	29	17	6	08	35	5	31	57	6	50	39	4	42	00	7	28	58	4	19	53	8
9	5	32	39	6	27	23	6	09	52	5	30	07	6	52	03	4	40	45	7	29	58	4	19	47	9
10	5	33	52	6	25	29	6	11	11	5	28	17	6	53	28	4	39	31	7	30	56	4	19	43	10
11	5	35	05	6	23	35	6	12	29	5	26	27	6	54	51	4	38	19	7	31	51	4	19	44	11
12	5	36	18	6	21	40	6	13	46	5	24	38	6	56	15	4	37	09	7	32	45	4	19	47	12
13	5	37	31	6	19	45	6	15	04	5	22	50	6	57	39	4	36	02	7	33	38	4	19	51	13
14	5	38	44	6	17	50	6	16	24	5	21	03	6	59	01	4	34	55	7	34	28	4	19	58	14
15	5	39	58	6	15	54	6	17	42	5	19	16	7	00	25	4	33	51	7	35	17	4	20	08	15
16	5	41	11	6	13	59	6	19	02	5	17	30	7	01	48	4	32	49	7	36	03	4	20	21	16
17	5	42	24	6	12	03	6	20	21	5	15	44	7	03	10	4	31	49	7	36	47	4	20	36	17
18	5	43	37	6	10	07	6	21	41	5	14	01	7	04	32	4	30	51	7	37	29	4	20	55	18
19	5	44	50	6	08	11	6	23	01	5	12	17	7	05	53	4	29	55	7	38	08	4	21	15	19
20	5	46	03	6	06	15	6	24	22	5	10	35	7	07	15	4	29	02	7	38	45	4	21	39	20
21	5	47	17	6	04	19	6	25	43	5	08	53	7	08	35	4	28	11	7	39	20	4	22	05	21
22	5	48	31	6	02	23	6	27	03	5	07	13	7	09	54	4	27	22	7	39	52	4	22	33	22
23	5	49	44	6	00	27	6	28	25	5	05	34	7	11	12	4	26	35	7	40	22	4	23	04	23
24	5	50	58	5	58	31	6	29	47	5	03	55	7	12	32	4	25	50	7	40	51	4	23	38	24
25	5	52	12	5	56	36	6	31	09	5	02	18	7	13	50	4	25	08	7	41	15	4	24	14	25
26	5	53	26	5	54	40	6	32	31	5	00	42	7	15	06	4	21	29	7	41	37	4	24	52	26
27	5	54	41	5	52	45	6	33	53	4	59	08	7	16	22	4	23	52	7	41	57	4	25	32	27
28	5	55	55	5	50	50	6	35	16	4	57	34	7	17	37	4	23	17	7	42	14	4	26	16	28
29	5	57	10	5	48	55	6	36	39	4	56	02	7	18	51	4	22	45	7	42	29	4	27	02	29
30	5	58	25	5	47	00	6	38	03	4	54	31	7	20	04	4	22	15	7	42	41	4	27	49	30
31	...	...	...	...	...	...	6	39	26	4	53	02	...	...	...	...	...	...	7	42	51	4	28	39	31

I have the honour to be, sir,

Your obedient servant,

R. M. STEWART.

APPENDIX No. 5.

REPORT OF THE CHIEF ASTRONOMER, 1907.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS, 1906

BY

J. Macara.

CONTENTS.

APPENDIX No. 5.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS.

OTTAWA, ONT., March 30, 1907.

W. F. KING, Esq., B.A., LL.D.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to transmit herewith a tabular statement of the differences of longitude and the latitude results of stations observed in 1906. Annexed thereto is, also, a description of the stations occupied.

A synopsis of the statement giving the longitude and latitude of the various stations will be found on page 256.

I have the honour to be, sir,
Your obedient servant,

J. MACARA.

DIFFERENCE OF LONGITUDE BETWEEN CLIFF ST. TRANSIT HOUSE AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	h. m. s.	h. m. s.	s.	s.	m. s.	s.	s.	s.	s.	s.		
May 3..	0 0 10·182	0 0 10·193	-06·698	±·005	-14·831	±·006	2·049	2·060	2·054	±·008	....	....
" 13..	45·336	45·337	-06·981	±·011	-50·189	±·007	2·128	2·129	2·128	±·013	....	....
" 14..	48·774	48·799	-06·940	±·012	-53·748	±·008	1·966	1·991	1·978	±·014	....	....
" 21..	57·927	57·933	-06·924	±·009	-01 02·770	±·011	2·081	2·087	2·084	±·014	....	....
" 23..	59·940	59·945	-06·970	±·011	-01 04·877	±·012	2·033	2·038	2·036	±·016	....	....

Observers { W.—R. M. Stewart.
E.—F. A. McDiarmid.

Weighted Mean..... 2·058 s. ±·006 s.

Date.	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	Time of Transmission.
	s.	s.	s.	s.	m. s.	s.	s.	s.	s.	s.		
May 15..	53·180	53·185	-06·822	±·016	-58·445	±·010	1·557	1·562	1·559	±·019	....	....
" 16..	53·304	53·297	-06·678	±·007	-58·608	±·011	1·374	1·367	1·370	±·013	....	....
" 17..	53·504	53·510	-06·788	±·010	-58·748	±·008	1·544	1·550	1·547	±·013	....	....
" 18..	52·778	52·765	-06·746	±·010	-57·987	±·012	1·537	1·524	1·530	±·015	....	....
" 19..	53·746	53·746	-06·719	±·008	-58·919	±·010	1·546	1·546	1·546	±·013	....	....
" 20..	57·459	57·456	-06·627	±·010	-01 -02·641	±·010	1·445	1·442	1·444	±·014	....	....

Observers { W.—F. A. McDiarmid.
E.—R. M. Stewart.

	h.	m.	s.	s.
Weighted Mean			1·491	±·006
$d\lambda$			1·775	±·005
λ Cliff St. Transit House	5	02	50·022	±·052
λ Dominion Observatory	5	02	51·797	±·052

DIFFERENCE OF LONGITUDE BETWEEN NEW LISKEARD AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	h. m. s.	h. m. s.	s.	s.	s.	s.	m. s.	m. s.	m. s.	s.	s.	s.
June 2..	0 15 44·134	0 15 44·004	−14·779	±·010	−05·914	±·014	15 52·999	15 52·869	15 52·934	±·017	·096	·065
" 3...	15 43·495	15 43·375	−15·374	±·018	−05·882	±·020	·987	·867	·927	±·027	·089	·060
" 6...	15 44·165	15 44·052	−14·171	±·011	−05·544	±·008	·792	·679	·735	±·014	·103	·057
" 8...	15 45·487	15 45·367	−12·549	±·010	−05·135	±·015	·901	·781	·841	±·018	·003	·060
" 9...	15 47·916	15 47·761	−09·820	±·010	−04·820	±·016	·916	·761	·838	±·020	·000	·078
" 10...	15 45·941	15 45·812	−11·595	±·014	−04·615	±·011	·921	·792	·856	±·018	·018	·065

Observers—W.—F. A. McDiarmid.
E.—R. M. Stewart.

	h. m. s.	s.
Weighted mean	15 52·838	±·007
Personal Equation....	·364	±·004
λDominion Observatory....	5 02 51·797	±·052
λNew Liskeard	5 18 44·999	±·052

DIFFERENCE OF LONGITUDE BETWEEN RIVIÈRE OUELLE AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	h. m. s.	h. m. s.	s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.	s.
June 21...	0 22 17·823	0 22 17·682	−29·099	±·013	−00·504	±·010	0 22 46·418	0 22 46·277	0 22 46·348	±·016	·054	·070
" 25...	22·966	22·812	−30·095	±·008	−06·588	±·009	46·473	46·319	46·396	±·012	·006	·077
" 27...	53·114	52·982	+03·256	±·006	−03·325	±·010	46·533	46 401	46·467	±·012	·065	·079
" 29...	06 215	06·096	−39·970	±·016	+00·266	±·012	46·451	46·332	46·392	±·020	·010	·060

	h. m. s.	s.
Weighted mean...........	0 22 46·402	±·009
Personal Equation.........	−·364	±·004
λDominion Observatory....	5 02 51·797	±·052
λRivière Ouelle......	4 40 05·759	±·052

Observers—W.—R. M. Stewart.
E.—F. A. McDiarmid.

DIFFERENCE OF LONGITUDE BETWEEN MANIWAKI AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	m. s.	m. s.	s.	s.	s.	s.	m. s.	m. s.	m. s.	s.		s.
July 6..	51·993	51·917	−10·700	±·010	−·290	±·011	1 02·403	1 02·327	1 02·365	±·015	....	·038
" 7..	54·987	54·889	−07·944	±·012	−·410	±·011	1 02·521	1 02·423	1 02·472	±·016	....	·049
" 9..	1 02·727	1 02·654	− ·234	±·018	−·497	±·008	1 02·464	1 02·391	1 02·427	±·020	....	·037

Observers—W.—F. A. McDiarmid.
E. —R. M. Stewart.

	h. m. s.	s.
Weighted mean...........	1 02·418	±·009
Personal Equation..........	·364	....
λDominion Observatory....	5 02 51·797	±·052
λManiwaki	5 03 54·579	±·052

DIFFERENCE OF LONGITUDE BETWEEN BOUNDARY AND VANCOUVER.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	h. m. s.	h. m. s.	m. s.	s.	m. s.	s.	h. m. s.	h. m. s.	h. m. s.	s.		s.
Aug. 22..	1 11 50·247	1 11 49·790	1 29 856	±·023	1 11·413	±·028	1 11 31·804	1 11 31·347	1 11 31·576	±·036	....	·219
" 25..	11 30·723	11 30·284	21·426	±·010	22·472	±·013	·769	·330	·549	±·016	....	·219
" 27..	11 14·084	11 13·635	12·309	±·010	30·087	±·010	·862	·413	·637	±·014	....	·224
" 29..	10 57·959	10 57·516	00·385	±·020	34·271	±·012	·845	·402	·623	±·023	....	·221
" 31..	11 08·610	11 08·203	13·281	±·010	36·537	±·010	·866	·459	·662	±·014	....	·203
Sept. 2..	11 05·078	11 04·657	12·846	±·013	39·483	±·010	·715	·294	·505	±·016	... .	·211

Observers—W.—F. A. McDiarmid.
E. —Otto Klotz.

	h. m. s.
Weighted mean............	1 11 31·596
λVancouver............ ...	8 12 28·461
λBoundary	9 24 00·057

DIFFERENCE OF LONGITUDE BETWEEN BOUNDARY AND FORT EGBERT.

Date.	Difference of Chronograph.		Clock Correction.				Difference of Longitude.					Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Probable Error.	Eastern Station.	Probable Error.	Western Signals.	Eastern Signals.	Mean.	Probable Error.	v.	
1906.	s.	s.	s.		m. s.	s.	s.	s.	s.			
Aug. 19..	48·145	48·145	−3·446	......	1 34·744	±·010	50·045	50·045	50·045	....	....	....
" 22..	41·291	41·291	−1·837	....	29·434	±·014	49·980	49·980	49·980	....	....	....
" 23..	37·182	37·182	−0·316	....	26·837	±·019	49·971	49·971	49·971	....	....	... .
" 25 .	27·758	27·762	+3·654	....	21·408	±·010	49·996	49·992	49·994	....	....	....
" 28..	10·077	10·077	+6·949	....	06·941	±·009	49·915	49·915	49·915	....	....	....
" 29..	02·057	02·065	+8·575	....	00·712	±·020	50·080	50·072	50·076	... .	....	....

Observers—W.—Edwin Smith.
E. —F. A. McDiarmid.

	h. m.	s.
Mean..........		49·998
λFort Egbert ..	9 24	50·058
λBoundary.....	9 24	00·060

LONGITUDE AND LATITUDE OF STATIONS OBSERVED IN 1906.

Place	Difference of Longitude h. m. s.	To	Longitude h. m. s.	Longitude ° ′ ″	Latitude ° ′ ″	″
Dominion Observatory	1·775	Cliff St. transit house	5 02 51·797	75 42 56·96		
New Liskeard	15 53·202	Dominion Observatory	5 18 44·999	79 41 14·99	47 30 33·58	± ·12
Rivière Ouelle	22 46·038	" "	4 40 05·759	70 01 26·39	47 29 04·86	± ·11
Maniwaki	1 02·782	" "	5 03 54·579	75 58 38·69	46 22 28·40	± ·13
Boundary	1 11 31·596	Vancouver (1900)	*9 23 59·970	140 59 59·55	64 40 51·42	± ·16
"	1 11 31·596	" (1905)	*9 24 00·057	141 00 00·86		
"	49·998	Fort Egbert	*9 24 00·060	141 00 00·90		
Vancouver					49 17 46·07	± ·13

* Adjusted Longitude, 9h. 24m. 00·027s.

LOCAL POSITIONS OF ASTRONOMICAL STATIONS.

Dominion Observatory.—The reference point of the longitudes observed in 1906 is a temporary transit house, the meridian of which is $0^s \cdot 12$ east of the centre of the dome of the observatory.

New Liskeard.—The observatory pier is 25·5 feet south and 836·6 feet west of an iron post which is 145 feet S. 5° 20′ W. of the southwest corner of the Temiskaming and Northern Ontario Railway station house.

Rivière Ouelle.—The observatory pier is 18·7 feet south, and 180·3 feet east of the first mooring post on the east side of the wharf. It is also about 70 feet from the Intercolonial Railway crossing at the end of the wharf.

Maniwaki.—The observatory pier is 112·8 feet south and 69·8 feet west of the southwest corner of the Canadian Pacific Railway station house.

Boundary.—The observatory is on the south bank of the Yukon river and is 352 feet east of the 'Ogilvie Line' and about 20 feet south from the shore of the Yukon river.

Vancouver.—The observatory is at Brockton Point in Stanley Park.

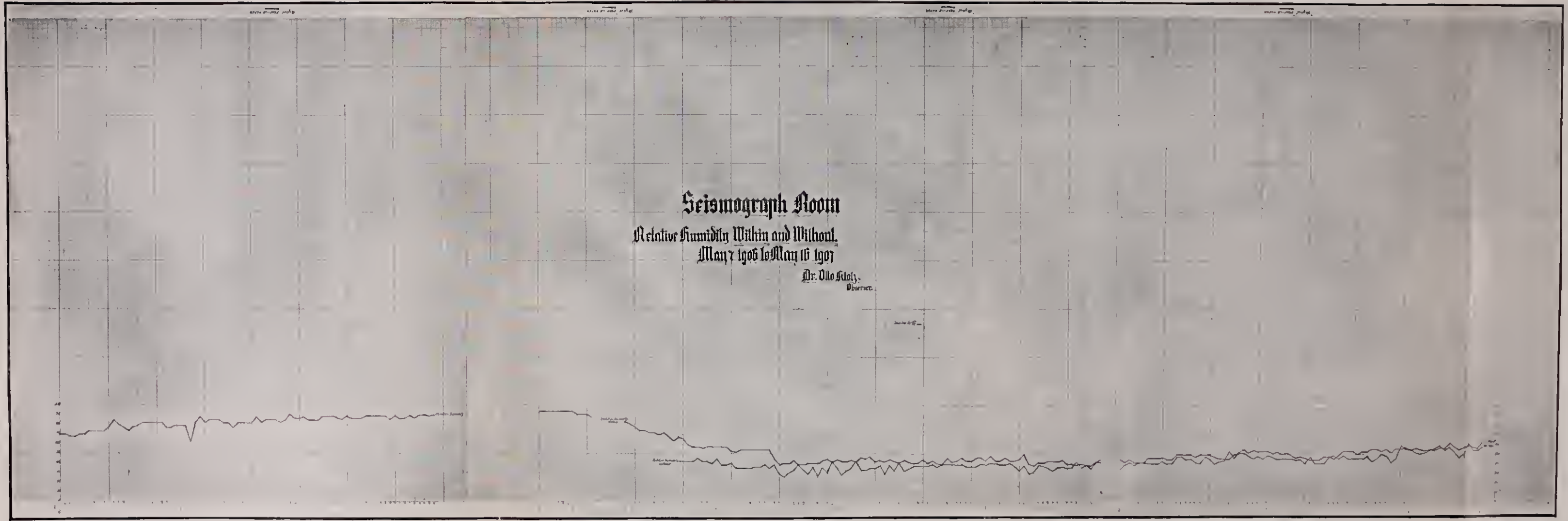

Seismograph Room
Relative Humidity Within and Without.
May 7 1906 to May 16 1907
Dr. Otto Klotz,
Observer.

FIG. 3.

DEPARTMENT OF THE INTERIOR

ANNUAL REPORT

OF THE

TOPOGRAPHICAL SURVEYS BRANCH

1906-1907

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1908

[No. 25*b*—1908.]

TABLE OF CONTENTS

REPORT

OF THE

SURVEYOR GENERAL OF DOMINION LANDS

1906-1907

Department of the Interior,
Topographical Surveys Branch,
Ottawa, September 16, 1907.

The Deputy Minister of the Interior,
Ottawa.

Sir,—I have the honour to submit the following report on the operations of the Topographical Surveys Branch for last year.

Heretofore the annual report has been for the fiscal year which ended June 30. Owing to the fact that June 30 came in the middle of the surveying season and the consequent difficulty of estimating the surveys made to that date, it has been the practice to make the statement and estimates of surveys in the field for the calendar year. Now that the end of the fiscal year has been changed to March 31, the fiscal year and the surveying season correspond fairly well, and it will be possible in future to have all statements for the fiscal year. In order, however, to bring this report to date, it is being made to cover the surveys for fifteen months, from January 1, 1906, to March 31, 1907.

SURVEYS FOR THE FIFTEEN MONTHS ENDING MARCH 31, 1907.

During this period, one hundred and forty-nine whole townships and eleven fractional townships were completely subdivided, while one hundred and forty-two townships were partially subdivided. Also, twenty-nine whole townships and one fractional township were completely re-surveyed while one hundred and twenty-three townships were partially re-surveyed. Sixty-four survey parties were employed, fifty-five being engaged on township surveys and nine on other surveys. Of the parties organized, thirty-five were paid by the day and twenty-nine were working under contract. Four of the parties under daily pay were located in Manitoba, eight in Saskatchewan, eight in Alberta, five in British Columbia, one in the Northwest Territories, and nine were part of the time in one province and part in another. Six contractors were located in Manitoba, seven in Saskatchewan, thirteen in Alberta, one in British Columbia and two part of the time in one province and part in another.

The contract surveys were inspected by Messrs. Geo. McMillan, P. R. A. Belanger, G. J. Lonergan, L. E. Fontaine, G. A. Grover and E. W. Hubbell, but with the exception of Mr. McMillan, their time was not entirely occupied with this work. The number of contracts examined was twenty-four.

TOWNSHIP SURVEYS.

The reports of the surveyors in charge of parties are given as appendices 13 to 45 inclusive; a perusal of these reports shows many instances of hard work and devotion to duty.

An illustration of what surveyors may have to contend with is afforded by the experience of Mr. J. N. Wallace, who established the fourteenth base line from the third to the second meridian, and the latter meridian northerly to Saskatchewan river. The need of this survey was imperative; it was expected to prove a difficult undertaking, but the necessity of completing it had been impressed upon Mr. Wallace. Starting from Prince Albert in the latter part of May, difficulties at the beginning were only those usually met with in a bush survey, but after crossing the Saskatchewan, some of the endless muskegs of that northern country were encountered, and then the troubles of the party commenced. Mr. Wallace tried to find a way round, but there was none around these muskegs, and he had to go right through. After floundering nearly three months, in the fall of the year, through these half frozen swamps, he found himself, towards the end of December, at the foot of the Pasquia mountains, a rough stretch of country rising 1,400 feet above Carrot river. Five of his horses were dead, the remainder were rapidly failing, and he was far from supplies. 'We had been,' he says, 'through some hard work in the muskegs, but the experience of getting the line over these hills, or rather mountains, put all else in the shade. Not only had we the deep snow and the rough country, but being on the northerly slope of the mountains, we were exposed to the bitter winds coming in over the vast open areas to the north, and were deprived by the slope of the small amount of warmth in the sun, as it seldom rose, so far as the valleys are concerned, until ten o'clock, and set about half-past one or two.' The survey was finally completed on March 12; its success was due not only to pluck and energy displayed by Mr. Wallace, but also to his excellent arrangements for feeding his pack train and provisioning his party. Incidentally he discusses transportation by dogs and by pack horses, and he indicates the considerations which must guide a surveyor in adopting one or the other mode of transportation.

Another notable example of devotion to duty is furnished by Mr. A. W. Johnson, who is in charge of the surveys in the western half of the British Columbia railway belt. For the last three years, a considerable part of his time has been spent in marking upon the ground the limit of the belt. This line was laid down on the maps at a fixed distance of twenty miles from the railway, and as may well be imagined, it goes over some of the wildest parts of the mountains. The survey of such a line requires steady nerves and continuous hard work. Such luxuries as tents are not to be thought of, and the bill of fare must be reduced to bare necessities. The men take with them only what they can carry on their backs, and the heaviest load is for the surveyor. 'I cannot,' Mr. Johnson says, 'spend months grading trails. People often say to me: "Why do you pack on your back?" I have found that unless I do so, and lead when difficult, dangerous, or dirty work is to be done, the men will not do it either, or if they do, only in a slip-shod, half-hearted way.'

Many other instances might be cited showing that the services of surveyors, as a class, deserve hearty appreciation.

The parties were distributed from the eastern boundary of Manitoba to the Pacific coast.

Mr. C. F. Aylsworth, D.L.S., who was making surveys and re-surveys in eastern Manitoba, speaks of the industrial possibilities of Beausejour. He reports that the peculiar quality of the sand in that district is especially adapted for the manufacture of glass. A company of Germans has been formed and a factory has been erected in a place convenient to the sand, which is found in unlimited quantities. Cement blocks and steam-dried white bricks are also manufactured there, and all three industries promise well.

Mr. Wm. Christie, D.L.S., was employed on re-survey work in eastern Manitoba, and Mr. W. J. Deans, D.L.S., on similar work as well as on some new surveys in the provinces of Manitoba and Saskatchewan.

Mr. Geo. A. Grover, D.L.S., was at work in Manitoba on re-surveys and the inspection of surveys made under contract. For some years Teulon has been the end of the Stonewall branch of the Canadian Pacific railway, but this year the company is extending the line farther north, intending, Mr. Grover believes, to run eventually to Icelandic river on lake Winnipeg. This should prove a profitable line, for though the country is at present largely broken by marshes and swamps, these should gradually diminish with deforestation, and the soil in nearly all parts is excellent. This locality would seem to be well adapted for mixed farming and dairying, and the proximity of the great and rapidly growing market of Winnipeg would assure the settler good prices for his produce. The Canadian Northern Railway company also intends to extend its line along the shores of lake Manitoba from Oak Point. This also should prove a valuable extension, but there is a wide stretch beween lakes Manitoba and Winnipeg that neither road seems desirous of entering, though the reason is not apparent, for it is a fertile country and fairly well settled, particularly when its distance from the railway anl the difficulty of road travel are considered. Moreover, this should be a cheap country to build a railway through, there being no great engineering difficulties to overcome.

Oak Point is situated in a park-like piece of country, with oak clumps and prairie alternating, which faces on lake Manitoba. It has great natural beauty and Mr. Grover believes it is soon to be made into a summer resort. This neighbourhood has been settled for some time and the farmers all seem to be doing well. Cream is shipped to Winnipeg in large quantities, which will doubtless increase when better facilities for handling are provided.

Mr. David Beatty, D.L.S., made some correction surveys north of Prince Albert and east of Battleford.

Mr. E. W. Hubbell, D.L.S., was employed on re-survey work and inspection of surveys made under contract. Speaking generally of that portion of the province of Saskatchewan extending from Prince Albert in the north to Willow Bunch in the south, and from Milford in the east to Swift Current in the west, it may be said that of the thirty thousand square miles, twenty-five thousand are excellent agricultural land. It is being rapidly settled by a superior class of immigrants, many of whom may be designated as Canadian-Americans, men born in Canada, who emigrated to the United States, lived there many years, married, became possessed of property, and who now being persuaded that they can better their condition, have sold out and have taken up homesteads in the Canadian west. Mr. Hubbell estimates that, in the above mentioned district, for every square mile now under cultivation there are two hundred square miles of virgin soil.

Mr. W. R. Reilly, D.L.S., was employed on re-survey work in the province of Saskatchewan.

Mr. A. H. Hawkins, D.L.S., was engaged on surveys and re-surveys in the southern part of Saskatchewan and Alberta. On the way to make an examination of the third correction line he passed through Stirling and Lethbridge. Stirling is the centre of a new Mormon settlement and seems to be in a thriving condition. A large beet-root sugar factory at Raymond, some six miles west of Stirling, has created a very profitable industry. Irrigation schemes are being pushed in all directions, and the excellent produce of all kinds testifies to the fertility of the soil when properly watered. As one nears Lethbridge, several large irrigation canals are passed and the country assumes a still more settled aspect. Good buildings, larger stacks of grain and more fences mark the advance of civilization.

Similar surveys were made in central and southern Alberta by Mr. W. F. O'Hara, D.L.S.

Mr. A. W. Ponton, D.L.S., was employed during the early part of 1906 on block outline surveys in northern Alberta. Part of his work was in the vicinity of Lac la

Biche. The country in this neighbourhood is generally wooded, poplar being found on the high land, and spruce in the swamps. The spruce timber available is sufficient to supply all lumber required for early settlement, but is too scattered for commercial purposes. A portable saw-mill would best meet local requirements. The soil is generally a good clay loam, becoming lighter and more of a sandy loam as the lake shore is approached. Lac la Biche has all the requisites for a summer resort, plenty of fish and game and beautiful scenery.

Mr. H. W. Selby, D.L.S., was in the vicinity of Lesser Slave lake, northern Alberta. The country is well suited for agriculture, but until there is nearer railway communication there will be no great influx of settlers, as there is no outlet for their produce.

Mr. Arthur Saint Cyr, D.L.S., ran some block lines in the Peace River district. In the vicinity of Prairie River Settlement the quality of the soil is all that can be desired, and this section bids fair to become one of the most prosperous in the country. At Smoky river there has been much damage done by fires.

The settlers at Peace River Landing and at Brick's Settlement are at a great disadvantage on account of the scarcity of roads to their hay meadows. Coal is found in many places and the climate is better than that of the country to the south.

Mr. R. W. Cautley, D.L.S., who was surveying block outlines in Alberta, speaks of the great activity of the Edmonton district in railway construction, building, farming and lumbering. This has caused an unlimited and consequently an unsatisfied demand for labour and horses which has raised the wages of one, and the price of the other. In the vicinity of the important and growing town of Athabaska Landing there are several scattered settlements, but there yet remains much land that is suitable for occupation, and there is no doubt that a larger number of settlers will come into this country during the next year or two, particularly as it is served by the best wagon road out of Edmonton and Fort Saskatchewan, namely, the Athabaska Landing trail.

In southern Alberta Mr. A. L. MacLennan, D.L.S., was employed in making subdivision surveys and Mr. C. F. Miles, D.L.S., on survey and re-survey work. In the greater portion of the district traversed, that is, in the wooded country, there is an abundance of game. This wooded portion is the chief hunting grounds for the Stony Indians, who kill deer in great numbers. Unless some restrictions are imposed to stop this indiscriminate slaughter, deer in this district will soon be exterminated. Nearly all the streams are well stocked with fish, the principal varieties being mountain, speckled and bull trout and grayling. There are also plenty of mountain grouse and partridge, and in certain localities a few prairie chicken.

Mr. C. C. Fairchild, D.L.S., was also working in southern Alberta.

Mr. L. E. Fontaine, D.L.S., was employed in southern and central Alberta in making surveys and re-surveys and in inspecting contracts. During the season he travelled over that part of Alberta lying between townships 37 and 52 between the fourth and fifth meridians. Great changes, he notes, have taken place in that district since 1898. Then a farm house or a ranch would be found every thirty or forty miles, but now the traveller is never out of sight of one or the other, and instead of vast wildernesses, beautiful fields of waving grain are now to be seen in every direction.

Mr. L. T. Bray, D.L.S., was engaged in subdivision and re-survey work in southern Alberta.

Mr. G. J. Lonergan, D.L.S., was employed in central Alberta in re-survey work and in the inspection of surveys made under contract. Following the Victoria trail northeast from Fort Saskatchewan, the country passed through is all well settled. Mixed farming is successfully carried on, considerable attention being devoted to hog raising. There is a splendid opening here for a large pork packing establishment. At present there is a small plant, but it is hopelessly inadequate. Contrary to the general idea, Stony plain is not a rough, rocky place. It is level, the soil is a rich sandy loam and it is known to grow the best No. 1 hard wheat in the Edmonton district. This plain was formerly part of the reservation for the Stony Indians, and hence its name. At St. Paul de Metis there is a Roman Catholic mission which was started eight years ago by the Rev. Father Therien. They have changed a scrub country into a profitable farm and beautiful garden, and have built a large church, a school and a convent. The mission has a steam thresher, a saw-mill, a shingle mill, a flour mill and a crusher. besides a full supply of farming machinery.

Mr. Jos. E. Ross, D.L.S.. during the past season was making surveys in the railway belt, Kamloops district, British Columbia. Near Ashcroft the soil is of such an absorbent nature that irrigation has a tendency to cause slides. At Spatsum the land is stony, hilly and broken, and fit only for grazing. Gypsum deposits occur here, and some development has been made. The valley of Incomappleux river is bounded by mountains on each side. This valley is fit for settlement, with plenty of timber on the higher grounds. Valuable minerals have been found high up in the mountains, but cannot be worked at a profit, owing to the high cost of transportation.

Mr. A. W. Johnson, D.L.S., was in the western portion of the railway belt in British Columbia. During the season he made a re-survey of the townsite of Hope. All that is needed to make this place a resort for tourists, is a railway, because a pleasanter spot for a summer holiday could scarcely be found. There is splendid trout fishing close to the village, mountain climbing and big game shooting for those who care to take the risk of climbing after goats, or the trouble of forcing their way through the thick brush to the high open slides which are the feeding grounds of bears. Another place that would make an ideal summer resort is Chilliwak lake. It would be easy to build a good wagon road up to the lake and then it could be reached in a day from the town of Chilliwak. The fishing is good, the scenery magnificent and there is nearly always a good sailing breeze.

MISCELLANEOUS SURVEYS.

Mr. J. F. Richard, D.L.S., surveyed settlements at Cumberland House, The Pas and Big Eddy on Saskatchewan river. Cumberland House, including the Indian reserve, has about 600 inhabitants, two-thirds at least of which are of Indian origin. The language generally spoken is Cree, although several of the half-breeds understand English, and a few of them understand French. A considerable trade in furs is carried on.

Big Eddy Settlement is situated to the north of Saskatchewan river on the rear line of The Pas Indian reserve. There is no cultivable land unless extensive draining operations are carried out, the country being a plain covered with moss from twelve to twenty-four inches deep. The population, including the Indians, numbers about 500; they profess the Anglican religion. A branch of the Canadian Northern railway running towards Hudson bay will probably reach The Pas during the course of the summer.

Mr. J. B. Saint Cyr, D.L.S., made a survey of the settlements in the neighbourhood of Fort Vermilion, on Peace river. Large tracts are well adapted for farming and ranching; grain paid very well during recent years, the Hudson's Bay company paying as much as one dollar and fifty cents a bushel for wheat. Extensive beds of limestone have been found, as well as large deposits of salt near Salt river. There is a seam of good soft coal at a place called 'The Cliff,' fifteen miles north of Peace River Landing; it is about three to five feet thick. Fish and game are found in abundance.

While making various miscellaneous surveys and supervising some of the arrangements for transport, &c., Mr. P. R. A. Belanger, D.L.S., in the course of the season travelled several hundred miles across the different provinces, and found everywhere an activity greater than at any time in the past. In the Edmonton district the country is filling up fast, although there is still a large quantity of desirable land ready for settlement. This district is an ideal country for farmers from Ontario and Quebec who cannot be content to settle in open country where wood is not found for miles around.

On his way from Kamsack to the Touchwood hills and Prince Albert, he passed through three Doukhobor villages, Veregin, Buchanan and a village situated about two miles west of Buchanan. The houses are in rows a few feet distant from one another, are built with great symmetry and have a very neat, clean appearance. The Doukhobors, he says, are a very moral, quiet and industrious people, and, notwithstanding their occasional foolish pilgrimages, are undoubtedly desirable settlers. They have already cultivated a large proportion of their land, and their crops rank among the best in the locality.

At a short distance north of Touchwood Hills postoffice, there is a small settlement named Wishart established several years ago on the western edge of Round plain. This is a very rich country, the farmers are all well off and they carry on mixed farming with great success. Mr. Belanger saw there some of the best wheat that was grown in the west last summer. The adjoining land, the Round plain, is, however, mostly vacant, although the land is much the same. This is because speculators have acquired it with scrip and are holding it at a high price.

Mr. R. C. Laurie, D.L.S., made a re-survey of the townsite of South Battleford.

Mr. J. A. Macdonell was engaged in an exploration survey for the purpose of selecting three and a half million acres, a grant to the Dominion government in that portion of the Peace River district of British Columbia lying east of the Rocky mountains and adjoining the province of Alberta.

Mr. J. A. Kirk, D.L.S., made some miscellaneous surveys along Blaeberry creek, in the railway belt in British Columbia. The valley of Blaeberry creek is of no apparent value except for its timber. The soil is not favourable for timber of large size, hence the large cedar is usually hollow, and large healthy trees of any kind are rare. Still the valley produces fair timber, which with proper protection will prove a valuable asset.

Mr. P. A. Carson, D.L.S., continued the triangulation of the railway belt in British Columbia, the main object of this work being to furnish points of reference for the extension of subdivision surveys at a distance from the railway.

Mr. Arthur O. Wheeler, topographer, extended his photo-topographical survey of the Yoho Park in the Rocky mountains. Altogether forty-seven ascents were made and eighty-nine camera stations occupied, from which four hundred and seventy-one plates were exposed. The districts round Mts. Douglas and Drummond furnish a paradise for botanists and those fond of camping amidst beautiful scenery. The locality may be said to be one of the most attractive of the Rocky mountains.

Irrigation surveys were continued under the direction of Mr. John Stewart, D.L.S., Commissioner of Irrigation, Calgary, Alberta.

EXPLORATION SURVEYS.

Four parties under Messrs. J. W. McLaggan, P. G. Stewart, A. D. Moodie and W. Thibaudeau, were detailed to explore the country along the route of the proposed branch of the Canadian Northern railway between Erwood and Fort Churchill, on Hudson bay. This line is to pass through The Pas, the part between Erwood and The Pas being now under construction.

Mr. J. W. McLaggan examined the country between The Pas, Paint lake and Burntwood river.

Messrs. P. G. Stewart and A. D. Moodie explored between Erwood and The Pas, Mr. Stewart being allotted the western portion and Mr. Moodie the eastern portion of this tract of country, while Mr. W. Thibaudeau examined the country lying between Fort Churchill and The Pas.

The object of these surveys was to get a detailed description of the country as to its general character, the nature of the soil, its fitness for agriculture, the value, quantity and location of the timber, the mineral resources and the climate.

Mr. J. W. McLaggan reported on the district between The Pas, Paint lake and Burntwood river. This is a sportsman's paradise. During the trip, he saw ten moose, six bears, one deer, one timber wolf, over a dozen lynx, a number of mink and other fur-bearing animals and ducks and geese innumerable. There are spots of good farming land and there should be no difficulty in raising good crops of all the hardy grains and vegetables, but the difficulty would be to make roads from one place to another, as the country between the spots of good land is rough and rocky.

The whole country from Grass river to Burntwood river, with the exception of small areas along the lakes and rivers, has been swept by fire. There is a growth of young timber coming up since the fire, which may be of value in time. As a mineral country there is a wide field for prospectors; Mr. McLaggan saw indications of gold, silver, iron and limestone. The preliminary survey of the railway to Hudson bay has already been made from The Pas to the southeast of Reed lake; he thinks that from there the railway should cross Grass river between Reed and Wekusko lakes, and continuing down the north side of Grass river and Setting lake, pass to the north of Paint lake. This route would take the railway through the part of the country where there would be the most traffic.

Mr. P. G. Stewart explored the region northwest of Etoimami and of the Hudson Bay branch of the Canadian Northern railway to The Pas. All through, the country is well covered with timber of all kinds, but poplar and spruce are most plentiful. He estimates the amount of standing timber available in this tract at about 600,000,000 feet B.M. The country is much the same as that explored by Mr. J. W. McLaggan.

Mr. A. D. Moodie's exploration was along the right of way of the Canadian Northern railway, between Erwood and The Pas. The part first examined was that section lying between Leaf lake on the east, and the Canadian Northern railway right of way on the west. The larger part of this section consists of mossy muskegs sparsely dotted with spruce and tamarack scrub, and of gravel ridges, with spruce and small poplar; it is consequently unfit for agriculture. The poplar is mostly small, and is good only for pulpwood. Spruce suitable for lumbering is scattered. Moose, caribou, bears and smaller fur-bearing animals are abundant.

The general character of the country from the north end of Leaf lake to The Pas and as far as thirty miles east of the grade, which is already constructed to the latter point, is very similar to that of the section just described, except that the timber is of better quality and is more plentiful.

The country lying to the east and north of Little Pasquia river is composed entirely of muskeg with spruce and tamarack scrub. Its character can be judged from the fact that for days together the party was compelled to wade in water to the knees.

The population of The Pas is about five hundred, including Indians. Most of the inhabitants belong to the Church of England, which has a mission under the charge of Mr. Edwards. The village consists of a few half-breed houses, two stores and the mission.

The branch of the Canadian Northern railway to Hudson bay runs through a muskeg country nearly the whole way from Etoimami to The Pas, a distance of eighty-nine miles. The engineers discovered that the muskeg of this particular section rested on a solid foundation of limestone gravel at a depth of three to six feet below the surface, and they claim that once the muskeg is drained a good road-bed will be obtained.

Mr. W. Thibaudeau, C.E., explored the country lying between Fort Churchill, on Hudson bay, and The Pas, on Saskatchewan river.

Churchill harbour has an entrance 2,000 feet wide and vessels drawing thirty-six feet of water may approach to within 200 yards of the west shore, while vessels drawing twenty-four feet may approach to within 150 yards of the east shore. No great difficulty will be experienced in keeping the harbour clear of ice all the year round. Churchill harbour lies between two peninsulas. On the west peninsula, sandstone, limestone and white quartzite are found. On the east peninsula there are splendid building sites and plenty of good limestone for building purposes.

Fort Prince of Wales, at the west of the entrance to the harbour, was built in 1733. The walls are thirty-four feet thick and sixteen feet high. It was originally mounted with forty cannon.

The present Fort Churchill is situated on the western shore about five miles from the mouth of Churchill river. This is the headquarters of the Hudson's Bay Co.

Timber for fuel is plentiful along the river. Salmon trout and whitefish are to be had at all seasons. Potatoes and vegetables are successfully grown, and good hay is to be had in abundance on both sides of the river. Game of all kinds is plentiful.

Between Churchill and North rivers the ridges are overgrown with small spruce and tamarack, but for the most part the country is level; it is covered with moss and small ponds and is constantly frozen up.

The same description applies to the land between Churchill and Owl rivers.

About one-third of the country from Fort Chrchill to The Pas is marsh. The higher lands are covered with spruce and tamarack, suitable only for fuel and pulpwood. No minerals of any kind are to be seen. Water-power is available from Deer, North, Churchill, Nelson, Burntwood and Grass rivers. Whitefish abound in all the lakes, and some trout, pike and sucker are occasionally to be had. Moose and caribou may be seen in fair numbers and also some rabbits, spruce grouse and ptarmigan. The total distance covered by Mr. Thibaudeau on his exploration was 690 miles.

The following is a comparison of the mileage surveyed since 1904:—

—	Fifteen months Jan. 1, 1906 to Mar. 31, 1907.	1905.	1904.
	Miles.	Miles.	Miles.
Township outlines	1,306	1,591	1,285
Section lines	8,962	10,544	24,488
Traverse	1,848	1,809	4,441
Re-survey	4,948	2,579	7,699
Total for season	17,064	16,523	37,913
Number of parties	56	46	80
Average miles per party	305	359	474

The following table shows the mileage surveyed by the parties under daily pay and by the parties under contract:—

Work of Parties Under Daily Pay.	Fifteen months, Jan. 1, 1906, to Mar. 31, 1907.	1905.	1904.
	Miles.	Miles.	Miles.
Township outlines	756	1,008	719
Section lines	1,035	939	235
Traverse	643	421	223
Re-survey	4,815	2,499	2,122
Total for the season	7,249	4,867	3,299
Number of parties	29	26	22
Average miles per party	250	187	150

Work of Parties Under Contract.	Fifteen months, Jan. 1, 1906, to Mar. 31, 1907.	1905.	1904.
	Miles.	Miles.	Miles.
Township outlines	550	583	566
Section lines	7,927	9,605	24,253
Traverse	1,205	1,388	4,218
Re-survey	133	80	2,809
Total for the season	9,815	11,656	31,846
Number of parties	27	20	57
Average miles per party	364	583	559

NOTE.—Owing to the nature of their work, the parties under Messrs. P. A. Carson, R. C. Laurie, J. A. Macdonell, J. W. McLaggan, A. D. Moodie, P. G. Stewart, W. Thibaudeau, and A. O. Wheeler, are not included in the statement of mileage for the fifteen months from January 1, 1906, to March 31, 1907.

DESCRIPTION OF TOWNSHIPS.

Descriptions of the townships subdivided have been compiled from the surveyors' reports received during the nine months ending March 31, 1907; they are given as appendix No. 46. The townships are put in order of township, range and meridian, and the descriptions are preceded by a list of all townships described.

Until the year 1893 such descriptions were published from time to time in separate volumes, but these volumes are now out of print and, moreover, are out of date, the last fifteen or twenty years not being included. As many applications are made for such information, the need of revised editions of these descriptions is becoming urgent, and it is hoped that they may be prepared at an early date.

SURVEY OF BLOCK OUTLINES IN THE PEACE RIVER DISTRICT.

The Peace River district having attracted considerable attention during recent years, a short account, such as may properly come within the scope of this report, of the initial surveys within the district may be opportune. A brief description of the method adopted in locating an initial point, with a passing notice of the difficulties encountered in a new field and a statement of the accuracy of the work performed as proven by later surveys, is all that will be attempted. For a description of the country, its resources, its climate, the fertility of its soil and the beauty of its scenery, other sources of information must be consulted.

The position of the sixth initial meridian in longitude 118° affects directly the location of the 120th meridian of longitude, which in the vicinity of Peace river forms the boundary line between the provinces of Alberta and British Columbia. It is, therefore, important that the position occupied by the sixth initial meridian, as surveyed on the ground, be established beyond reasonable doubt. Recent base line surveys in that district show that the posts on this meridian are about sixteen chains too far south, and the whole line about five chains too near to the fifth meridian.

This difference arose in the traverse survey by which an initial point on the sixth meridian was first established, but was not discovered until the spring of 1905, when the survey of the nineteenth base line between the fifth and sixth meridians was completed, affording the first check on the position of the sixth meridian.

The inception of the regular surveys in the Peace River district goes back to 1882, when it was decided to establish some block outlines. For this purpose a portion of the sixth initial meridian had first to be located. The nearest Dominion land survey line, at that time, was the fifth meridian, which, during the season of 1882 had been produced north across Athabaska river to the north boundary of township 71. The position of the sixth meridian was established by a cross country traverse from a point on the fifth meridian near its intersection with Athabaska river.

Mr. Wm. T. Thompson, D.T.S., who was entrusted with this survey, left Edmonton with his party on September 22, 1882, travelling by pack trail towards Lesser Slave Lake settlement, until the Pembina river was reached. At this point two scows were constructed of spruce lumber made by whip-sawing the large timber found in the river valley. The outfit and supplies were conveyed in these scows down the Pembina and Athabaska rivers to the mouth of Lesser Slave river, and up this to the foot of the lake. Here a number of sets of observations for latitude by transits over the prime vertical were taken by Mr. Thompson while waiting for ice to form before proceeding with the survey.

Early in December the geodetic traverse was commenced from the foot of Lesser Slave lake and continued easterly through the most favourable country. The general course of the river was followed for a distance of thirty miles to the junction of Lesser Slave and Athabaska rivers, where a point was established to be connected later with the fifth meridian by Mr. W. Ogilvie, D.L.S., when his survey of that line should cross Athabaska river. This point was indicated by a blazed tree marked 'Station O.' The traverse line was then run westerly across the lake and continued through the most open country by way of Stinking lake to Smoky river, where further observations for latitude were made. Care was taken to keep the line as nearly as possible in an east and west direction and the alignment was checked by frequent observations for azimuth.

From the foot of Lesser Slave lake to this point all transportation was necessarily by means of dog trains furnished by the natives, who had a considerable settlement at the head of the lake. Spring overtook the party at the crossing of Smoky river, and the method of transporting supplies which had been of such service during the winter months had to be abandoned. The dog trains were sent back to the lake and pack horses procured for bringing in supplies and moving the outfit.

In the meantime Mr. Ogilvie had established a connection between the fifth meridian and the point previously marked at the mouth of Lesser Slave river by Mr. Thompson. This point was found to be 186·03 chains west and 55·08 chains north of the northeast corner of section 13 in township 71, range 1, west of the fifth meridian. On receipt of this information Mr. Thompson continued his traverse line westerly the required distance to reach the sixth meridian. The differences of latitude and longitude between the initial and terminal points of the traverse line were carefully computed by means of geodetic formulæ and the latitude checked by further observations of transits over the prime vertical. The mean of four nights' observations made the latitude of the terminal point nearly seven seconds less than the latitude computed from the data furnished by the traverse line. Owing to the proximity of Birch hills to the north and the valley of Smoky river to the south, the location was not considered favourable for the determination of the latitude, which might be affected by abnormal deviations of the plumb line. As cloudy weather prevented observations later at more favourable points on the production of the meridian northerly, only a slight correction was made to the computed latitude before permanently planting the posts on the meridian. Practically the meridian was established from the traverse alone, no use being made of the latitude observations.

It is to be regretted that Mr. Thompson was not favoured with better weather so that a number of observations could have been taken at points suited for the accurate determination of the latitude. A difference of 16 chains in the position of the posting on the meridian represents a difference of 10 seconds in latitude. With good weather and a favourable location it is practically certain that the surveyor, by exercising his usual precautions, would have very materially reduced this discrepancy. Even then, had he trusted his latitude observations, the error would have been reduced to a little over five chains. The position in longitude of the meridian line checks fairly close with the measurements made on the different base lines which have since been completed between the fifth and sixth meridians. According to the twentieth base line, which for some distance passes through the same locality as the traverse line, the position of the sixth meridian differs from its theoretic location by only 1·69 chains. Such agreement reflects credit on the chain-bearers engaged on the traverse.

The linear measurements were made by means of a steel band tape; the observations for azimuth and latitude and the production of the line were effected with a six-inch transit theodolite. When it is remembered that the length of the steel band tape is affected directly by the temperature and varies from other causes, that the surface irregularities and unequal elevation of the country, as well as the personal errors of the chain-bearers are factors which affect the accuracy of the surveyor's measurements, but the value of which cannot be satisfactorily determined, the result, in respect to longitude, is very creditable.

During the progress of the survey Mr. Thompson's assistant made a micrometer survey of Lesser Slave river and lake, ascertaining also the leading features of the adjacent country.

The fifth and sixth meridians are now connected by five consecutive base lines, which taken together, furnish the best available evidence as to the position which the sixth initial meridian occupies with respect to the 118th meridian of longitude with which it theoretically should coincide. The sixteenth base line was run by R. W. Cautley, D.L.S., in the summer of 1904, and winter of 1905; the seventeenth was surveyed in three sections by A. Saint Cyr, D.L.S., in 1904, A. Driscoll, D.L.S., in 1905, and A. Saint Cyr, D.L.S., in 1906, respectively; the eighteenth was also surveyed in three sections by A. Saint Cyr, D.L.S., in 1904, J. N. Wallace, D.L.S., in 1905, and A. Saint Cyr, D.L.S., in 1906, respectively; the survey of the nineteenth was commenced by E. Bray, D.L.S., in 1904, and completed by A. Saint Cyr, D.L.S., in 1905, while the twentieth was run by H. W. Selby, D.L.S., in 1905, with the exception of the most westerly eleven miles, which had been previously surveyed by C. C. Fairchild, D.L.S.

The closings of the different base lines show the sixth meridian as located on the ground, to be somewhat east of its theoretic position, and the posting thereon to be too far south. The following table summarizes the evidence furnished by these lines:—

Base line.	Mer. too far east.	Posting too far south.
16 th.	8·78 chs.	15·24 chs.
17 "	4·85 "	17·00 "
18 "	7·14 "	15·77 "
19 "	3·02 "	18·44 "
20 "	1·69 "	16·41 "

A number of base lines have also been run west from the sixth meridian, two of which have been established as far as the boundary between Alberta and British Columbia. Various other outline surveys, as well, have been projected within the district, so that the way is now fairly prepared for the prosecution of subdivision work in any locality where such surveys may appear desirable.

It is the intention to move all the posts to correct latitude when the subdivision surveys are proceeded with.

A diagram showing the closings on the base lines between the fifth and sixth meridians accompanies this report.

THE WESTERN BOUNDARY OF THE CANADIAN PACIFIC RAILWAY BELT IN BRITISH COLUMBIA.

The Settlement Act of 1883 described the Canadian Pacific Railway belt as follows:—

'The public lands along the line of the railway before mentioned wherever it may be finally located to a width of twenty miles on each side of said line as provided in the order in council, section 11, admitting the province of British Columbia into confederation.'

In the Dominion order in council, approved on May 27, 1887, the western boundary of the belt is described as follows:—

'Commencing at the intersection of the international boundary with the waters of Semiahmoo bay, a branch of Boundary bay, an arm of the Pacific ocean; thence westerly and northerly following the shore of said Semiahmoo bay and also of Mud bay, another branch of said Boundary bay, to the easterly limit of a road known as Mud Bay road; thence northerly following the said limit of said road to the southern bank of Fraser river; thence northerly to the point where the easterly limit of the north road touches the north bank of Fraser river; thence northerly following the said limit of said north road to the southerly shore of Burrard inlet; thence northwesterly to Pt. Roche, being a point where the westerly shore of the north arm of Burrard inlet joins the northerly shore of the main arm of Burrard inlet; thence northerly following the westerly shore of the said north arm of Burrard inlet to the most northerly part of the same; thence due north to the north boundary of township 7, range 7, west of the seventh initial meridian according to the Dominion Lands system of surveys adopted in the survey of the railway belt in British Columbia.'

By the order in council approved on March 29, 1895, an agreement was to be concluded with the government of the province of British Columbia. Clause 1 of said order reads as follows: 'The province shall accept as the boundary of the railway belt the limits laid down and marked out by the Dominion order in council approved on May 27, 1887, and by the map attached thereto (a copy of which is hereto annexed), or the nearest township line to the boundary of the belt which would be found by actual admeasurement, as may be found by the Minister of the Interior most convenient.'

In the order in council of the British Columbia government, dated December 6, 1895, clause 1 reads as follows:—

'The province shall accept as the boundary of the railway belt the limits laid down and marked out by the Dominion order in council, approved on May 27, 1887, and by the map attached thereto (a copy of which is annexed to the said report of the Privy Council approved by His Excellency on March 29, 1895), or the nearest section line to the boundary of the belt which would be found by actual measurement as may be found by the Minister of the Interior most convenient.'

In a letter dated June 23, 1896, the Deputy Commissioner of Lands and Works, Victoria, B.C., was notified by the Deputy Minister of the Interior that it had been decided to adopt for the boundary the nearest section line to the boundary of the belt which would be found by actual measurement, and diagrams showing the section line in question were inclosed.

Attention was drawn to the fact that the boundary shown upon the diagrams stops at the creek flowing from the north into the head of the north arm of Burrard inlet, leaving the western boundary of the belt undefined, therefore, it appeared that another notification to the provincial government under the provisions of the provincial order in council of December 6, 1895, would be necessary to fix the western boundary of the belt.

In a letter dated April 9, 1903, the Deputy Commissioner of Lands and Works, British Columbia, was asked if the province would agree to accept for the western boundary the line described in the order of His Excellency the Governor General in Council, of May 27, 1887, to which a reply was received as follows:—

'In reply I beg to say that the boundaries referred to in that order, with the exception of that part which follows the westerly shore of the north arm of Burrard inlet, have always been understood by this government as agreed to between the province and the Dominion; but instead of the westerly shore of the north arm of Burrard inlet we have always considered the eastern shore of the north arm to be the boundary line, and we have sold and otherwise alienated islands lying in the said north arm. I, therefore, beg to suggest that the description in the order in council above referred to may be altered so as to make the easterly shore of the north arm the boundary between the provincial and Dominion lands.'

By the order in council of July 8, 1904, the eastern shore of the north arm of Burrard inlet was accepted as part of the western boundary of the railway belt, subject to the ratification of parliament and of the legislature of British Columbia, the said boundary to be as follows:—

'Commencing at the intersection of the international boundary with the waters of Semiahmoo bay, a branch of Boundary bay, an arm of the Pacific ocean; thence westerly and northerly following the shore of said Semiahmoo bay and also of Mud bay, another branch of said Boundary bay, to the eastern limit of a road known as Mud Bay road; thence northerly following the said limit of said road to the southern bank of Fraser river; thence northerly to the point where the eastern limit of the north road touches the north bank of Fraser river; thence northerly following the said limit of said north road to the southern shore of the main arm of Burrard inlet; thence due north to the northern shore of the said main arm; thence westerly following upon the said northern shore of the main arm to the eastern shore of the north arm of Burrard inlet; thence northerly following upon the eastern shore of the said north arm to the most northerly point of the peninsula between Bedwell bay and the said north arm; thence northeasterly on a straight line to the point where the northern boundary of township thirty-nine, west of the coast meridian intersects the eastern shore of the north arm of Burrard inlet; thence northerly following upon the said eastern shore to the mouth of Mesliloet river, a stream flowing from the north into the head of the said north arm; thence northerly along the middle of the main channel of the said Mesliloet river to the point of its intersection with the north boundary of township seven, in range seven, west of the seventh meridian, according to the Dominion Lands system adopted in the survey of the railway belt in British Columbia.'

In a report of a committee of the executive council of the government of British Columbia, approved by the Lieutenant Governor on August 13, 1904, it is stated that 'The committee observe that the recommendation of the Minister of the Interior that, subject to the ratification of parliament and of the legislature of British Columbia, the eastern shore of the north arm of Burrard inlet be accepted as part of the western boundary of the railway belt, is approved.

'The committee advise that the Dominion government be informed that the provincial government approves and accepts the recommendation of the minister.'

The Secretary of State called the attention of the Lieutenant Governor of British Columbia to the fact that the provincial minute, approved on August 13, 1904, merely accepted the eastern shore of the north arm of Burrard inlet as part of the western boundary of the railway belt, not the whole western boundary as described by metes and bounds in the minute of the Privy Council approved by the Governor General on July 8, 1904.

The report of a committee of the executive council, approved by the Lieutenant Governor on March 3, 1905, was, therefore, substituted for that of August 13, 1904. This accepts the eastern shore of the north arm of Burrard inlet as part of the western boundary of the railway belt and approves and confirms the said boundary as further defined in the order in council of July 8, 1904.

In a report of the committee of the Privy Council, approved by the Governor General on July 15, 1905, it was recommended that, as the government of the Dominion and of the province of British Columbia had agreed to accept a certain line for the western boundary of the Canadian Pacific Railway belt, the Minister of Justice be asked to have prepared for submission to parliament at its next session a Bill containing the necessary provisions for an Act to ratify the boundary in question in so far as the Dominion of Canada is concerned, and it was further recommended that the Lieutenant Governor of British Columbia be asked to have the necessary action taken by his government to ratify such boundary in so far as the province of British Columbia is concerned, by an Act of the legislature of that province.

In a report of a committee of the executive council, approved by the Lieutenant Governor on August 10, 1905, it was recommended that the Attorney General be requested to prepare a Bill to be laid before the legislature at its next session to ratify the boundary in question so far as the province is concerned. Accordingly a Bill was introduced, but when it came up for discussion it was pointed out that the Mud Bay road mentioned in the order of the Governor General in Council of July 15, 1905, does not extend to Mud bay, and at its northern end joins what is known as the Yale road, which leads to Fraser river at Brownsville, opposite New Westminster, and that instead of extending to the north bank of Fraser river, the north road, mentioned in said order, ends at the northeasterly limit of the city of New Westminster. To meet this difficulty it was considered necessary to make some amendments in the description of the boundary contained in the said order of the Governor General in Council, and the Dominion government having signified its consent to the changes, the Bill received the sanction of the Lieutenant Governor of British Columbia on March 12, 1906.

The description of the western boundary of the railway belt as ratified by the Provincial Act is as follows:—

'Commencing at the intersection of the international boundary with the waters of Semiahmoo bay, a branch of Boundary bay, an arm of the Pacific ocean; thence westerly and northerly, following the shore of the said Semiahmoo bay, and of Mud bay, another branch of the said Boundary bay, to a point on the shore of Mud bay at the intersection of the west boundary line of township two, New Westminster district, with the waters of said Mud bay; thence north along the said west boundary of township two, to the northwest corner of said township two; thence northerly along the eastern side lines of the Mud Bay (or Scott) road, and the Yale road, to the south bank of Fraser river at Brownsville; thence northerly, crossing Fraser river to a point on the north bank of the said river where the eastern side line of the north road produced south would intersect the north bank of Fraser river; thence north to the eastern side line of said north road; thence north along the said eastern side line of said north road to its intersection with the south shore of Burrard inlet; thence north to the north shore line of Burrard inlet; thence westerly and northerly following the shore line of Burrard inlet to the most northerly point of the peninsula between Bedwell bay and the north arm of Burrard inlet; thence northeasterly on a straight line to the point where the northern boundary of township thirty-nine west of the coast meridian intersects the eastern shore of the north arm of Burrard inlet; thence northerly, following upon the said eastern shore to the mouth of the Mesliloet river, a stream flowing from the north into the head of said north arm; thence northerly along the middle of the main channel of the said Mesliloet river to the point of its intersection with the northern boundary of township seven, in range seven, west of the seventh meridian, according to the Dominion Lands system adopted in the surveys of the railway belt in British Columbia.'

A Bill to ratify the agreement between the government of the Dominion of Canada and the government of the province of British Columbia respecting the western boundary of the railway belt received the sanction of the Governor General on March 22, 1907.

ASTRONOMICAL FIELD TABLES.

The astronomical field tables, as described in the report of 1906, are still being issued. These tables were formerly set up in type and printed in the ordinary way, but it was difficult to obtain them from the printers in time for issue to the surveyors. Inasmuch, however, as a great deal of the matter contained in the tables is the same from year to year, forms containing all those parts which never vary have been made, so that when a new set of tables is required, only those parts which vary have to be added to the forms. The forms themselves, as well as the variable data to be added, are stamped by means of type, and the titles, footnotes, &c., are printed by a small handpress and pasted on the form in the proper place. The finished table is then reduced and printed by photo-zincography, thus avoiding all delays in printing.

The diagram of the altitude and azimuth of the pole star, as described in the report of 1906, is issued periodically with the field tables.

A star map is now being constructed for the convenience of observers for latitude. It will facilitate the selection of pairs of stars for Talcott's method.

IMPROVEMENT OF SURVEYS.

The improvement in execution of fieldwork, mentioned in previous reports, is well illustrated by a remark made by one of our surveyors who was engaged in retracing old surveys and afterwards in making an inspection of some recent subdivisions. He writes: 'To change from retracing old lines run twenty years ago to inspecting present day contract work is, I fear, not in the interest of rigid inspections. There has been such an improvement, not in any particular, but in every detail of the surveys made in this country in the past twenty years that one would hesitate to speak of them as being the same class of work. In no way could the advantage of the numerous modifications in the Manual and in the field instruments used be more markedly illustrated than by this change which I was forced to make this season. The lines examined in contracts of 1906 were straight, the chainage good and the corners well marked, none of which could be said, as a rule, of the more ancient surveys in this country.'

CORRESPONDENCE.

The correspondence consisted of:

Letters received	7,300
Letters sent	8,209

The staff consists of the secretary, one clerk, two stenographers and typewriters and two messengers.

ACCOUNTS.

The accountant's record shows:

Number of accounts dealt with	493
Amount of accounts	$515,040
Number of cheques forwarded	1,896

The staff consirts of an accountant and an assistant accountant.

OFFICE STAFF.

A list of the office staff of the Topographical Surveys Branch at Ottawa is given in appendix No. 11.

A number of changes have taken place during the nine months ending March 31, 1907. In the Metcalfe Street office Mr. Percy Wilkinson has been appointed assistant accountant, and J. O'Leary messenger in place of F. T. Ellis, who was transferred to another branch. Mr. Geo. H. Watt, chief of the first division, has resigned to take a survey contract. Messrs. H. G. Barber, A. J. Elder, W. T. Green, F. W. Rice, E. E. D. Wilson and W. E. Weld have been absent all or part of the time, acting temporarily as assistants to surveyors. Mr. P. A. Carson, who is in charge of the trigonometrical survey, spent the summer in British Columbia. Miss G. B. Campbell and Messrs. H. A. Mackenzie, C. C. Smith, Wm. Crawford and H. L. Chilver of this office, and Messrs. M. W. Sharon and S. B. Roach, of the geographer's office, have resigned. Mr. L. J. Gleeson has been detailed to another branch and Mr. F. H. Mackie has been transferred to the office of the chief astronomer. Mr. H. J. Higgerty has been transferred from the lithographic office to the Timber and Mines Branch.

The additions to the staff during the past nine months are: A. Brown, E. L. Burkholder, J. C. Ball, E. E. Brice, C. Fitzgerald, J. B. Hutton, R. V. Heathcott, M. Kimpe, J. F. Moran, J. A. Macdonald, F. L Marriott, J W. Rochon, H. J. Smith, R. O. Spreckley, A. Tremblay, J. N. Goodall, who was re-appointed, and P. F. X. Genest, who was transferred from the Yukon office. Mr. E. Villeneuve was changed from the lithographic office to the office of the chief draughtsman. Those appointed to the lithographic office are: S. Boyle, J. Gagnon and S. H. Shore; the latter was recently transferred to the office of the chief draughtsman. Messrs. W. Anderson, W. Blue, J. Beveridge and F. B. Inkster were appointed to the geographer's staff; Mr. E. G. Ouimet to the photographer's staff, and Mr. N. Landry to the survey records office as messenger.

OFFICE OF THE CHIEF DRAUGHTSMAN.

A summary of the work executed in the chief draughtsman's office is given as appendix No. 6.

This part of the branch is divided into five divisions.

First Division—Instructions and General Information.

In this division instructions are prepared for all surveys to be performed in the field. When the surveyor has been selected, instructions are prepared for him giving any directions that may be necessary in connection with the survey. In the case of parties under day pay, the surveyor is also instructed as to the size of party, the place of organization, the nature of the transport outfit and the rate of pay to employees. Outline sketches are furnished to him showing the monuments, bearings and distances of the lines of Dominion land surveys already established in the vicinity of his work. He is also supplied with maps or plans of all Hudson's Bay Company reserves and Indian reserves in the neighbourhood. Field books, astronomical field tables, stationery, forms for accounts, statutory declarations, &c., are also furnished. During the nine months ending March 31, 1907, instructions were issued for eighty-six survey parties, involving the preparation of 798 sketches, and 328 maps and tracings.

In this division all returns of survey from the surveyors are received. They are dated, stamped, and posted in the various registers under the name of the surveyor. They are then sent to the second division for examination. The receipts during the nine months were 630 progress sketches, 390 books of field notes, 169 plans, 56 timber reports and 382 statutory declarations. After examination and the compilation of the plans, the books of field notes are returned to this division and forwarded to the survey records office. During the nine months 643 field books and the returns of 67 miscellaneous surveys were placed on record. Entries are also made in the registers for all township and other plans printed. Plans of 520 townships, 4 townsites, 49 miscellaneous surveys and 52 sectional sheets were printed during the nine months.

When the progress sketches sent in by the surveyor have been examined and found satisfactory, preliminary plans for the townships are issued, four copies for each township. One copy is placed on file in this office and one each furnished to the survey records office, the Land Patents Branch and the land agent. The object of these plans is to allow of the land being opened for entry at once, without waiting for the final examination of the surveyor's returns and the issue of the official plan. Preliminary plans of 179 townships were issued during the nine months.

At the close of each month a list of the surveys approved during the month is forwarded to the secretary of the department. Every six months another list of the whole townships, fractional townships and partially surveyed townships, the surveys of which have been approved, is sent to the secretary. Under the provisions of subclause 7 of clause 22 of the Dominion Lands Act, the governor of the Hudson's Bay company is to be notified of the surveys approved, and the list is for the purpose of giving the notice called for by the Act.

Numerous communications on miscellaneous matters pertaining to surveys are dealt with in this division. To reply intelligently to many of these questions requires days of search for information among various sources, frequently in different branches of the department. During the nine months 743 such communications were dealt with, involving the preparation of 258 sketches, maps, &c.

Second Division—Examination of Surveyors' Returns.

A detailed description of the system of examining and dealing with surveyors' returns was given in the annual report for the year ending June 30, 1906. The same system is still in force, with some few improvements in the minor details.

The room formerly occupied by the geographer and his staff on the second floor of the Metcalfe Street office, having been vacated, the partition between it and the room occupied by the compiling and examining staff, and also an unused elevator shaft were removed, thus affording increased accommodation and better working facilities. Temporary quarters were procured in the Orme building on Wellington street, while this work was in progress, and the disadvantage of part of the staff being removed from registers, plans of former surveys and other sources of information, retarded the work to some extent. In addition to the removal of the partition, a ventilating system was installed, this being easily accomplished by utilizing part of the space formerly occupied by the elevator shaft. The value of this provision for ventilation is inestimable, as a plentiful supply of good fresh air is now available, whereas before, no provision whatever was made for ventilation.

The work has been materially increased by the passage of an Act respecting roads and road allowances in the provinces of Saskatchewan and Alberta (section 6 of chapter 100 of the Revised Statutes of Canada), which provides that where a survey is made of a road diversion, a duplicate copy of the plan of such survey, approved by the chief engineer of the Department of Public Works of such province, shall be forthwith transmitted by the said Department of Public Works to the Surveyor General, who, within one month from the receipt of it by him, may require the plan of such survey to be withdrawn from the land titles office by the Department of Public Works of such province.

Before patents issue for Dominion lands required by railway companies for the right of way of their lines, the plans of such railways must be examined and approved by the Surveyor General. A large number of these plans have accumulated and their examination involves considerable work. Although some progress has been made in re-issuing township plans out of print, the number of plans of which reprints are required has increased rather than diminished during the past nine months. The demand for township plans has become so great, that the stock of those issued years ago, of which only a small edition was printed, soon became exhausted. Larger editions are now printed, so that unless on account of additional surveys, plans recently issued are not likely to require re-issue for many years to come.

The work of this division during the past nine months is as follows:—

Plans compiled	409
Subdivision returns examined	312
Outline returns examined	122
Miscellaneous survey returns examined	210
New editions of township plans	72
Progress sketches examined—contractors	205
Progress sketches examined—day men	270
Memoranda sent to surveyors	329
Memoranda received from surveyors	342

Third Division—Drawing for Reproduction.

The third division of the draughting staff is engaged chiefly in making finished copies of township and other plans for reproduction by photo-zincography or lithography. During the nine months 527 plans of townships were prepared for printing. For part of this period, while the offices were being renovated, the staff was divided, a number of the draughtsmen remaining at the office on Metcalfe street, while the others were accommodated in temporary quarters on Wellington street. This separation of the staff impeded the progress of the work.

Seventy-nine drawings and plans of a miscellaneous nature were undertaken. Some of the most important of these were the astronomical field tables for the use of surveyors. The present method of preparing these and also the new star map, is described under a separate heading.

A map in colours, showing the route of the proposed Hudson Bay branch of the Canadian Northern Railway, was compiled and printed. This map shows the routes of explorers who recently visited the district, the main features of the country through which the railway will run. and the saving in rail transportation from the western provinces.

The original plans for photo-zincographing are carefully filed away; when new editions of any of them are required, it is only necessary to add the information obtained from later surveys and to photograph them again.

An improvement has been made in the attachment used in the stamp, for holding the type, while stamping a plan. The old holder (see fig. 1) consisted of a solid frame,

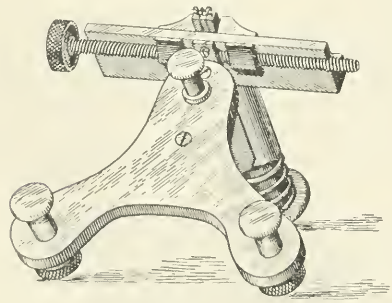


Fig. 2

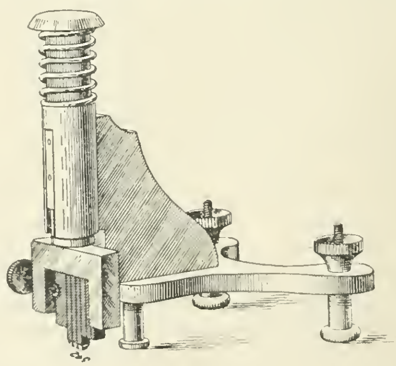


Fig 1.

cut out in the front to receive the type, with a horizontal thumb screw passing through one side, by means of which the type was held securely in place. This necessitated the use of quads or other small pieces of metal, in order to fill up the extra space in the holder, after the type had been placed at the centre. Considerable time was required to adjust each setting of type and quads; also the action of the end of the thumb screw against the soft metal of the quad soon wore it away and created a tendency for the screw to work out of line, enlarging the threaded hole in the holder.

The new holder (see fig. 2) consists of a one-piece frame, having the front shaped out to receive two movable jaws. These jaws have each a projection on the back which slides in a slot in the back of the holder. Through these projections and in the rear of the holder, passes a thumb screw having a bearing at its centre, half in the back of the holder and half in a small cap attached to the back of the holder by screws. This bearing being smaller than the body of the threaded parts of the screw and being situated in the centre of the holder, keeps the screw from moving laterally. One-half of the screw is threaded with a right-hand thread, the other half with a left-hand thread, the holes in the movable jaws being also threaded right-hand and left-hand. The result of this arrangement is that when the thumb screw is turned in one direction the jaws open away from the centre of the holder; when it is turned in the opposite direction the jaws move towards the centre and are capable of coming together at that point. They can hold the thinnest object securely, and whatever is held between them is always in a central position in the holder, and the use of quads for this purpose is done away with.

For the colouring of maps and plans, an air brush has been procured. The air brush is especially useful for colouring photographic enlargements of maps, as the paper used in photographing is often of such a character that it is impossible to put on an even tint in the ordinary way.

Fourth Division—British Columbia Surveys.

Most of the surveys in British Columbia were made by the regular surveyors, Messrs. J. E. Ross and A. W. Johnson. Both worked in winter, as well as in summer, in order to take advantage of weather conditions favourable to surveying operations in the various localities.

In addition to the work of the regular surveyors, a few returns have been received of surveys made for private individuals and of other small surveys.

The British Columbia section of the staff which, for three years, occupied quarters on Sparks street separated from the main office, was this year transferred to the space in the Surveyor General's office formerly occupied by the geographer's staff. This facilitates the work of the staff, the returns and information required for reference being more readily accessible.

The British Columbia surveyors remained so long in the field that their returns were somewhat delayed, and those received entailed more work than usual. As most of the traverse surveys in British Columbia were made for the purpose of establishing section corners and land boundaries, this portion of the work, which will this year contain well over one thousand courses, has to be carefully checked by latitudes and departures.

Forty-five township plans have been compiled, and three hundred and four miscellaneous plans and tracings have been made.

Fifth Division—Mapping.

The work of this division is the compilation and drawing of any maps that may be required. The staff has been engaged principally on the 'sectional sheets,' adding new surveys and other information and preparing them for new editions. Much new compilation has been added to the sectional sheets covering the railway belt in British Columbia so as to show the topography, not only within the railway belt, but also outside of it to the full size of the sheet. The sheets which extend over the west boundary of Alberta into British Columbia are also being added to, in the same way.

The compilation of the surveys of mineral claims in the Yukon Territory, showing their position on the general map on a scale of 40 chs. to an inch, has been kept up, but the number of lots so recorded has been very small compared with previous years.

SURVEY RECORDS' OFFICE.

A large portion of the survey records staff has been employed copying plans which have been out of print, and which were required by agents, land guides and companies in placing settlers on their lands.

Homestead maps, on a scale of one mile to an inch, showing the homesteads open for entry in the western provinces, have been completed and forwarded to the different sub-agents.

The amount of correspondence necessary to supply the largely increased demand for township plans was, on an average, between twenty-five and thirty letters per day.

The plans and files in connection with reservations of right of way for roads and railways in the provinces of Manitoba, Saskatchewan and Alberta, have greatly increased the work of this office. All these plans and files are recorded here. Every railway right of way plan is on file and the reservations for the right of way in the lands affected are noted. The correspondence in this connection, averaging between fifteen and twenty letters per day, goes through this branch.

The Eclipse Manufacturing company completed the cases, and finished all the other changes necessitated by their removal to their new quarters in the Canadian building. The printed plans of the parishes, settlements and town plots, were removed to their new places and re-indexed; this new arrangement does much to economize the time required for finding them.

A complete index of all the plans west of the fifth meridian, showing the character of the survey and the name of the surveyor for all original plans, has been compiled and has proved a valuable aid to ready reference.

The increase of work during the year has been so large that it is only by using the greatest care in indexing and arrangement that the present staff is able to keep pace with it.

PHOTOGRAPHIC OFFICE.

In presenting the report of the photographic office, it is interesting to note that the total amount of work executed during the nine months exceeded that executed during the twelve months ending June 30, 1906.

There is a large increase in the number of township plans, over one hundred having been reproduced in the month of January alone.

The dry plate work and the bromide enlarging have also greatly increased.

Hitherto the Geological Survey parties have, to a large extent, employed sketching for their surveys, but now they are beginning to use photography, which they find quicker and more satisfactory. Last season only one of their parties used photography, while this season it is expected that four or five will be equipped with the necessary photographic outfits. From the negatives, bromide enlargements are made in this office. This greater use of photography is the cause of the large increase in the number of bromide enlargements.

Considerable time has been spent on special work. The photo-lithographing of a section of Nelson river showing the proposed Hudson Bay railway, is a fair example of the use that can be made of photography in map making. This map was enlarged from a thirty-five mile scale to a twenty-five mile scale. Another interesting piece of work was the enlargement of part of Alberta, Saskatchewan and the Northwest Territories, from a thirty-five mile scale to a twelve mile scale. This work, which occupied only one week, would take at least three months if done by draughting.

The staff consists of one photographer in charge, one general photographer with three assistants, and one photo-lithographer and photo-engraver with two assistants.

Besides the development, printing and enlargement of the views taken by surveyors in the field, they have to copy, reduce and enlarge to proper scale the plans and maps used in compilations, to photograph the plans and maps sent in for reproduction and to prepare zincplates or transfers of the same. The photographic work of the Geological Survey Department has also been done here. A schedule of the work executed is given as appendix No. 9.

LITHOGRAPHIC OFFICE.

There has been no change in the method of doing the work in this office.

The statement of the work executed, given as appendix No. 10 to this report, shows a decrease in the number of maps printed but a decided increase in the number of the township plans.

The number of the staff is the same as last year; it consists of one foreman, one transferer, one power press printer and one press feeder.

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS.

The regular annual meeting of the board was held at Ottawa, beginning on the second Monday in February, 1907 (February 11), as directed by clause 101 of the Dominion Lands Act, and was continued until March 2. Special meetings were held on July 19, 1906, and March 21, 1907.

During the February meeting examinations were held simultaneously in Ottawa, Toronto, Winnipeg and Calgary. Professor L. B. Stewart, D.T.S., of the School of Practical Science, presided at the examination in Toronto; Mr. J. Lonsdale Doupe, D.L.S., in Winnipeg, and Mr. A. O. Wheeler, D.L.S., in Calgary.

It had also been arranged to hold a special examination at the same time in Vancouver, under Mr. E. B. Hermon, D.L.S., but the candidates did not present themselves.

Fifteen candidates passed the examination for admission as articled pupil, as follows:—

M. H. Baker, St. Thomas, Ont.
T. W. Brown, Alberton, Ont.
L. S. Cokely, Lethbridge, Alta.
A. S. Cram, Ottawa, Ont.
G. H. Ferguson, Toronto, Ont.
L. F. Heuperman, Edmonton, Alta.
W. G. McElhanney, Ottawa, Ont.
E. W. Murray, Seaforth, Ont.
J. L. Rannie, Toronto, Ont.
A. Roger, Ottawa, Ont.
A. H. D. Ross, Ottawa, Ont.
Alan Stewart, Ottawa, Ont.
A. G. Stuart, Montreal, P.Q.
A. H. Swinburn, Ottawa, Ont.
E. O. Wheeler, Calgary, Alta.

Fourteen candidates passed the final examination for admission as surveyor, as follows:—

N. A. Burwash, Toronto, Ont.
C. A. Chilver, Walkerville, Ont.
P. C. Coates, Toronto, Ont.

S. R. Crerar, Toronto, Ont.
C. H. Fullerton, New Liskeard, Ont.
P. Gillespie, Toronto, Ont.
W. T. Green, Ottawa, Ont.
G. B. McColl, Winnipeg, Man.
D. H. Nelles, Ottawa, Ont.
D. T. Townsend, Toronto, Ont.
J. E. Umbach, Ottawa, Ont.
W. H. Waddell, Hamilton, Ont.
J. Waldron, Pine Grove, Ont.
E. W. Walker, Regina, Sask.

Oaths of office and of allegiance and bonds for the sum of one thousand dollars each, as required by clause 115 of the Dominion Lands Act, were received from eleven candidates who had previously passed the necessary examinations for commissions as Dominion land surveyors and had complied with the other requirements of the Act.

Ten commissions as Dominion land surveyors were issued, as follows:—

E. R. Bingham, Toronto, Ont.
N. A. Burwash, Toronto, Ont.
C. A. Chilver, Walkerville, Ont.
S. R. Crerar, Toronto, Ont.
W. T. Green, Ottawa, Ont.
J. D. McLennan, Ottawa, Ont.
G. B. McColl, Winnipeg, Man.
D. H. Nelles, Ottawa, Ont.
D. T. Townsend, Toronto, Ont.
J. E. Umbach, Ottawa, Ont.

Every Dominion land surveyor is required by clause 125 of the Dominion Lands Act, to be in possession of a subsidiary standard measure furnished by the secretary of the board of examiners. Nine such standards were issued during the year.

A list of surveyors who have been furnished with standard measures up to March 31, 1907, will be found in appendix No. 3.

The correspondence of the board amounted to:

Letters, &c., received	571
Letters sent	435

The examination questions used at the examination in February, 1907, are submitted as appendix No. 12.

Synopsis of the Work of the Board.

The meeting of July 19, 1906, was a special meeting called to pass the necessary resolution admitting J. D. McLennan as a Dominion land surveyor, his commission having been withheld until the completion of his term of apprenticeship.

Previous to the annual meeting in February sets of question papers for the various examinations were prepared by the members of the board. At this meeting the answers of three candidates at the limited preliminary examination, seventeen at the full preliminary examination, nineteen at the final D.L.S. examination, and one at the D.T.S. examination were examined.

Some discussion took place on the regulation made at the meeting in May, 1906, whereby candidates obtaining 75 per cent or more on any subject are not required to write on such subject if they present themselves again. It was felt that from such candidates a higher percentage should be required than from those coming up for the first time. No action in the matter was taken at this meeting.

The question of who are eligible for examination under clause 111 of the Dominion Lands Act, having come up, it was decided that in future the secretary should accept articles for one year's service only from graduates of colleges and universities who hold proper diplomas.

Considerable time was taken up in discussing the regulations governing the examination for certificate as Dominion topographical surveyor; and the schedule of studies was re-arranged. It was agreed that before the next meeting a brief statement should be prepared setting forth the work to be covered in each subject of this examination, and a list of the books to be used in preparing for it. The work was divided among the members of the board, Dr. Deville taking three subjects, and Dr. Klotz and Dr. King four subjects each.

A resolution was passed fixing the percentage of marks required to pass any examination at 50 per cent in each subject, and allowing candidates who obtain the required 50 per cent in certain subjects, but fail in other subjects, to take supplementary examinations.

A special meeting of the board was held on March 21, at which the curriculum of studies for the D.T.S. examination was further considered and a list of text books prepared.

A resolution was also passed allowing candidates whose term of service at the time of examination is within three weeks of completion to write on such examination, provided that field work is complete at the time of writing. Commissions in such cases will be withheld until the completion of the full term of apprenticeship of one year or three years, as the case may be.

APPENDICES.

The following schedules and statements are appended:—

No. 1. Schedule of surveyors employed and work executed by them from July 1, 1906, to March 31, 1907.

No. 2. Schedule showing for each surveyor employed from Jan. 1, 1906, to Mar. 31, 1907, the number of miles surveyed, of township section lines, township outlines, traverses of lakes and rivers, and resurvey; also cost of same.

No. 3. List of Dominion land surveyors who have been supplied with standard measures.

No. 4. List of lots in the Yukon Territory surveys of which have been confirmed from July 1, 1906, to March 31, 1907.

No. 5. List of miscellaneous surveys in the Yukon Territory returns of which have been received during the nine months ending March 31, 1907.

No. 6. Statement of work executed in the office of the chief draughtsman.

No. 7. List of sectional maps revised, printed, reprinted and revised and reprinted from July 1, 1906, to March 31, 1907.

No. 8. Statement of work executed in the survey records office for the nine months ending March 31, 1907.

No. 9. Statement of work executed in the photographic office during the nine months ending March 31, 1907.

No. 10. Statement of work executed in the lithographic office during the nine months ending March 31, 1907.

No. 11. Names and duties of employees of the Topographical Surveys Branch at Ottawa.

No. 12. Examination papers of the Board of Examiners for Dominion land surveyors.

Nos. 13 to 45. Reports of the surveyors employed.

No. 46. Descriptions of surveyed townships submitted by Dominion land surveyors during the nine months ending March 31, 1907.

MAPS.

The following maps accompany this report:—

1. Diagram showing closings on base lines between the fifth and sixth meridians.

2. Mr. P. G. Stewart's exploration on the west side of the Canadian Northern railway from Etoimami to The Pas; to accompany his report.

3. Sketch map showing country near fourteenth base line, province of Saskatchewan, to accompany the report of J. N. Wallace, D.L.S.

4. Map to accompany J. W. McLaggan's report of exploration in Saskatchewan and the Northwest Territories.

5. Mr. A. D. Moodie's exploration from Etoimami to The Pas; to accompany his report.

6. Topographical survey of Canada—trigonometrical section. Triangulation in British Columbia. To accompany the report of P. A. Carson, D.L.S.

I have the honour to be, sir,

Your obedient servant,

E. DEVILLE,

Surveyor General.

APPENDICES

TYPOGRAPHICAL SURVEYS BRANCH.

SCHEDULES AND STATEMENTS.

APPENDIX No. 1.

SCHEDULE of Surveyors employed and work executed by them from July 1, 1906 to March 31, 1907.

Surveyor.	Address.	Description of work.
Aylsworth, C. F....	Madoc, Ont....	Re-survey of township 10 range 7, township 14 range 8, parts of townships 14 and 16 range 7, and parts of townships 15 ranges 7 and 8, all east of the principal meridian.
Baker, J. C.........	Vermilion, Alta.	Contract No. 14 of 1906; subdivision of township 59 range 20, township 58 range 21, and townships 61 ranges 25, 26 and 27, all west of the fourth meridian.
Beatty, David......	Parry Sound, Ont. ...	Correction survey in townships 51 ranges 27 and 28 west of the second meridian. Retracement surveys in the following townships west of the third meridian;—township 38 range 13, townships 45 ranges 9 and 10, townships 41, 42, 43 and 44 ranges 10 and 11, and townships 49 and 50 range 1. Retracement surveys in townships 50 ranges 26, 27 and 28 west of the second meridian.
Belanger, P. R. A...	Ottawa, Ont....	Inspection of contracts No. 18 of 1905 and Nos. 11 and 12 of 1906. Restoration survey in the following townships west of the second meridian;—townships 24 ranges 1, 13, 14 and 15, townships 25 ranges 12, 14, 15 and 16, townships 26 ranges 12, 13 and 15, township 27 range 7, townships 28 ranges 6 and 13, townships 29 ranges 13, 14 and 15, township 30 range 13, townships 31 ranges 12 and 13 and townships 32 ranges 9, 10 and 11. Restoration survey in the following townships, west of the principal meridian;—township 5 range 34, townships 6 ranges 30, 32 and 34, townships 7 and 8 ranges 32 and 34, township 24 range 29, township 26 range 28 and townships 30 and 32 range 29.
Bolton, Lewis.......	Listowel, Ont.........	Contract No. 3 of 1906; subdivision of townships 3 and 4 ranges 13 and 14, east of the principal meridian.
Bourgeault, A......	St. Jean Port Joli, Que.	Contract No. 11 of 1906; subdivision of townships 30 and 31 ranges 15 and 16, parts of township 30 range 14, and township 29 range 15, all west of the second meridian.
Bray, L. T.	Amherstburg, Ontario.	Re-survey in township 11 range 22, and subdivision in townships 1, 2, 3 and 4 range 30, west of the fourth meridian. Subdivision in townships 1 and 2 range 1, in township 5 range 2, in townships 6, 7, 8 and 9 range 3, in township 7 range 4, and in township 8 range 6, all west of of the fifth meridian
Carson, P. A	Ottawa, Ont....	Triangulation surveys in British Columbia, in connection with the Trigonometrical Section of the Topographical Survey of Canada.
Cautley, R. W......	Edmonton, Alta.....	Survey of the seventeenth base line across ranges 17 to 27 inclusive, west of the fourth meridian.
Cautley, R. H	Edmonton, Alta	Contract No. 16 of 1906; subdivision in townships 57, 58, 59 and 60 range 5, west of the fifth meridian.
Christie, Wm.......	Chesley, Ont..........	Re-survey in township 17 range 1, in township 18 range 2, in townships 19 and 20 ranges 3, 4 and 5, and in township 20 range 6: re-survey of part of the outlines of township 16 range 1, of township 19 range 6, of township 18 range 3 and of township 17 range 2, all west of the principal meridian.

APPENDIX No. 1.—Schedule of Surveyors employed and work executed by them from July 1, 1906, to March 31, 1907.—*Continued.*

Surveyor.	Address.	Description of work.
Deans, W. J.	Brandon, Man.	Subdivision in township 16 range 4, in townships 15, 16, 17 and 18 range 10, and in townships 14, 15, 16, 17 and 18 range 11 all west of the principal meridian. Re-survey of township 7 range 27, of townships 5, 6, 7 and 8 range 28 and of townships 5, 6, 7, 8 and 9 range 29, all west of the principal meridian. Re-survey of part of township 7 range 9, west of the second meridian. Miscellaneous surveys in township 17 range 21, west of the principal meridian.
Doupe, Jos.	Winnipeg, Man	Re-survey in township 6, range 14 west of the second meridian.
Drummond, Thos.	Montreal, Que	Contract No. 17 of 1906; subdivision of townships 57, 58, 59 and 60 range 6, west of the fifth meridian.
Dumais, P. T. C.	Hull, Que.	Contract No. 9 of 1906; subdivision of townships 26 ranges 12, 13 and 14, townships 25 and 26 range 10, and township 23 range 14, west of the principal meridian. Re-survey of townships 25 and 26 range 11, west of the principal meridian.
Edwards, Geo.	Ponoka, Alta.	Contract No. 13 of 1906; subdivision of townships 11 and 12 range 11; partial subdivision of townships 10 and 11 range 13, and townships 7, 8, 9, 10 and 11 range 1, west of the third meridian; survey of the east outline of townships 9 and 10 ranges 11 and 12 and of townships 5, 6, 7 and 8 range 2, west of the third meridian.
Fairchild, C. C.	Brantford, Ont.	Subdivision in townships 25, 26 and 27 range 11, in townships 25, 26, 27 and 28 range 12, and in township 24 range 8, all west of the fifth meridian. Miscellaneous work near Banff, Alta.
Fawcett, Thos	Niagara Falls, Ont.	Contract No. 20 of 1906; subdivision of townships 56, 57, 58 and 59 range 4, west of the fifth meridian.
Fontaine, L. E.	Lévis, Que.	Re-survey of township 42 range 27, west of the third meridian. Miscellaneous surveys in townships 41 and 42 range 1, in township 43 range 3, in township 37 range 4, in township 47 range 5, in townships 43, 44 and 47 range 6, in township 40 range 8, in townships 41 and 42 range 9, in township 44 range 10, in township 38 range 14, and in townships 39 ranges 15 and 16, all west of the fourth meridian. Re-survey of township 50 range 3 west of the fifth meridian. Inspection of contracts Nos. 5 and 22 of 1906.
Grover, Geo. A.	Toronto, Ont.	Re-survey of township 18 range 1, east of the principal meridian. Re-survey of townships 19 and 20 ranges 1 and 2, and of townships 22 ranges 7 and 8, west of the principal meridian. Inspection of contracts Nos. 3, 4, 5, 6, 7, 8 and 10 of 1906.
Hawkins, A. H.	Listowel, Ont.	Subdivision of township 2 range 29 west of the third meridian. Re-surveys in townships 1 ranges 12 and 13, in township 2 range 13, in townships 6 and 7 range 17, in townships 10 and 11 range 22 and in township 13 range 29, all west of the fourth meridian. Re-survey of outlines of townships 1 and 2 range 8, of townships 1, 2, 3 and 4 range 9, of townships 1 ranges 10, 11 and 14, of township 2 range 14 and of township 10 range 24, all west of the fourth meridian. Survey of part of the south outline of township 3 range 29 west of the third meridian.
Holcroft, H. S.	Toronto, Ont	Contract No. 10 of 1906; subdivision of township 7 range 9 and townships 6, 7, and 8 range 10, all east of the principal meridian. Subdivision of townships 7 and 8 ranges 27, 28, 29 and 30 west of the second meridian. Survey of the east outline of township 6 range 30, west of the second meridian.
Hopkins, M. W.	Edmonton, Alta.	Contract No. 23 of 1906; subdivision of townships 59 and 60 ranges 7, 8, 9 and 10, all west of the fourth meridian.
Hubbell, E. W.	Ottawa, Ont	Re-survey in township 22 range 1, in townships 21 and 22 range 2, in townships 21, 22 and 23 range 3, in townships 21 and 22 range 4, in townships 21 and 22 range 5, in townships 21 ranges 6 and 7 and in townships 21 and 22 range 8, all west of the third meridian. Re-survey in township 27 range 24, in township 24 range 28, in townships 18 and 19 range 29, and in townships 26 and 29 range 25, all west of the second meridian. Inspection of contracts Nos. 13 and 25 of 1906.

APPENDIX No. 1.—Schedule of Surveyors employed and work executed by them from July 1, 1906, to March 31, 1907.—*Continued.*

Surveyor.	Address	Description of Work.
Jephson, R. J	Winnipeg, Man.... ..	Miscellaneous surveys in townships 44 and 45 range 28 west of the principal meridian and in township 44 range 3 west of the second meridian.
Johnson, A. W....	Kamloops, B.C.	Subdivision in townships 1, 2, 3, 4 and 5 range 26, in township 1 range 27, in townships 2 and 3 range 24, in townships 2 and 4 range 25, in township 3 range 23, in townships 3 ranges 28 and 29, in township 4 range 28 and in township 15 range 27, all west of the sixth meridian. Subdivision in township 19 east of the coast meridian. Traverses in township 2 range 25, in townships 3 ranges 23, 24, 25 and 26, in townships 4 ranges 24, 25 and 26, in townships 5 ranges 25 and 26, in township 15 range 27, and in township 3 range 28, all west of the sixth meridian. Traverses in townships 19 and 20 east of the coast meridian.
Kirk, J. A	Revelstoke, B.C.	Double traverse of Blaeberry creek valley from the mouth to the northern limit of the railway belt, and part subdivision of township 28 range 22 west of the fifth meridian.
Knight, R. H.......	Edmonton, Alta......	Contract No. 21 of 1906; subdivision of townships 50 and 51 ranges 5 and 6, and townships 54 and 55 range 7, all west of the fifth meridian.
Lonergan, G. J. ...	Buckingham, Que.....	Re-surveys in townships 51 ranges 2 and 3 west of the fifth meridian and in townships 56 ranges 22 and 24 west of the fourth meridian. Correction surveys in townships 58 and 59 range 22 west of the fourth meridian. Miscellaneous surveys in township 59 range 23, in townships 59 ranges 17 and 18, in township 52 range 12, in township 60 range 14 and in township 55 range 4, all west of the fourth meridian; and in township 53 range 28 west of the third meridian. Subdivision in township 51 range 20 west of the fourth meridian. Correction survey at Fort Saskatchewan. Survey of outlines of township 56 range 25, of township 49 range 1, of township 57 range 14, all west of the fourth meridian. Survey of outlines of townships 53 and 54 ranges 27 and 28 west of the third meridian. Inspection of contract No. 23 of 1906.
Laurie, R. C..	Battleford, Sask..	Re-survey of the townsite of South Battleford.
Macdonell, J. A....	Winnipeg, Man..... .	Exploration survey of three and a half million acres, grant to the Dominion Government "in that portion of the Peace river district of British Columbia lying east of the Rocky mountains and adjoining the province of Alberta."
MacLennan, A. L ..	Toronto, Ont..........	Subdivision in townships 11 and 12 range 3, and in townships 10 and 11 range 4, and survey of the east outline of township 12 range 4, all west of the fifth meridian.
McFarlane, W. G...	Toronto, Ont.........	Contract No. 5 of 1906; subdivision of townships 34 and 35 range 22, townships 28 and 32 range 23, townships 24 and 35 range 25, and township 35 range 26, all west of the principal meridian. Subdivision of townships 7 and 8 ranges 14, 15 and 16, townships 6 ranges 13, 14, 15 and 16, township 7 range 13, and townships 3 ranges 12 and 13, all west of the fourth meridian.
McFee, A....	Innisfail, Alta........	Contract No. 22 of 1906; subdivision of township 28 range 18, and townships 35 ranges 14, 15 and 16, all west of the fourth meridian. Traverse in township 35 range 2 west of the fifth meridian.
McGrandle, Hugh..	Wetaskiwin, Alta....	Contract No. 18 of 1906; subdivision of townships 58 and 59 range 7; surveys of outlines in townships 57, 59 and 60 range 7, and in township 58 range 8; traverse in township 60 range 7, all west of the fifth meridian.
McLaggan, J. W....	Strathcona, Alta.......	Exploratory survey in the province of Saskatchewan and in Keewatin territory northeasterly from The Pas.
McMillan, Geo......	Ottawa, Ont....... ...	Inspection of contracts Nos. 12, 15, 17, 19 and 20 of 1905 and contracts Nos. 1, 14, 15, 16 and 21 of 1906. Traverses in townships 59 and 60 range 11, west of the fourth meridian.
Michaud, A	Edmonton, Alta...... (Since deceased)	Contract No. 19 of 1906; subdivision of townships 54, 55 and 56 range 5, west of the fifth meridian.

APPENDIX No. 1.—Schedule of Surveyors employed and work executed by them from July 1, 1906, to March 31, 1907.—*Continued.*

Surveyor.	Address.	Description of work.
Miles, C. F.	Toronto, Ont.	Subdivision in township 15 range 1, in townships 13, 14 and 15 range 2, in townships 17, 18, 19 and 20 range 3 and in townships 21 and 22 range 4, west of the fifth meridian. Survey of outlines of townships 12 ranges 3 and 4, west of the fifth meridian. Traverse in township 21 range 27, west of the fourth meridian.
Molloy, John	Winnipeg, Man.	Contracts Nos. 2 and 7 of 1906; subdivision of townships 1 and 2 range 10, townships 1, 2 and 6 range 11, townships 2, 3 and 6 range 12, townships 1, 5 and 6 range 13, townships 5, 6 and 7 range 14 and township 6 range 9; traverse in townships 13 and 14 ranges 12 and 13, all east of the principal meridian.
Montgomery, R. H.	Prince Albert, Sask.	Contract No. 12 of 1906; subdivision of townships 50 ranges 22, 23, 24, 25 and 26 and townships 51 ranges 22, 23 and 26 and survey of the east outline of townships 52 ranges 22, 23 and 24, all west of the second meridian. Subdivision of townships 50 ranges 2 and 3, and townships 51 ranges 1 and 2, all west of the third meridian.
Moodie, A. D.	Lakefield, Ont.	Exploration survey of the country between Erwood, Saskatchewan and The Pas, Keewatin along the right of way of the Canadian Northern railway.
O'Hara, W. F.	Ottawa, Ont.	Re-surveys in townships 32, 33 and 34 ranges 21 and 22, and in township 35 range 21 west of the fourth meridian. Miscellaneous surveys in township 38 range 28 west of the fourth meridian, and in township 38 range 1, west of the fifth meridian. Subdivision in township 5 range 3, west of the fifth meridian.
Parsons, J. L. R.	Winnipeg, Man.	Contracts No. 6 of 1906 and No. 3 of 1907; subdivision of townships 9 ranges 10 and 11, township 10 range 9 and townships 15 and 16 ranges 14 and 15, all east of the principal meridian; subdivision of townships 23 and 24 ranges 4, 6 and 7; subdivision in township 29 range 10, and survey of part of the outlines of township 28 range 10, all west of the principal meridian.
Reilly, W. R.	Regina, Sask.	Re-surveys in townships 33 and 34 ranges 1 and 2, in townships 38 ranges 1, 2 and 3, in township 37 range 1 and in township 35 range 6, all west of the third meridian. Re-surveys in townships 41 and 42 range 28, west of the second meridian. Partial re-surveys in township 34 range 6, west of the third meridian and in townships 41 and 42 range 28 west of the second meridian.
Richard, J. F.	Ste. Anne de la Pocatière, Que.	Settlement surveys at The Pas, Cumberland House and Big Eddy.
Rinfret, R.	Montreal, Que.	Contract No. 24 of 1906; subdivision of townships 65, 66, 67 and 68 range 13, townships 65, 66, 67 and 68 range 14, and townships 66 and 68 range 15; survey of the east outline of township 65 range 16, all west of the fourth meridian.
Ross, Jos. E.	Kamloops, B. C.	Subdivision surveys in townships 22 ranges 26 and 27, west of the fifth meridian; also in townships 23 ranges 2 and 3, in townships 22 and 23 range 16, in townships 18 and 22 range 17, in townships 17 ranges 17, 18 and 19, in township 16 range 18, and in townships 19 ranges 16, 17 and 18, all west of the sixth meridian. Traverses in townships 19 ranges 16, 17 and 18, in townships 17 and 18 range 17, in township 17 range 18, in townships 22 and 23 range 2, and in townships 21 and 22 range 1, all west of the sixth meridian; also in township 21 range 29 west of the fifth meridian. Surveys on the shores of Shuswap and Mara lakes. Traverse of Columbia river from Beavermouth to the north limit of the railway belt. Traverse of Incomappleux river and Boyd creek trail. Traverse of Huff lake and part of North Thompson river.
Roy, Geo. P.	Quebec, Que.	Contract No. 15 of 1906; subdivision of townships 58 and 59 range 27, west of the fourth meridian, and townships 60 ranges 3 and 4, west of the fifth meridian.

SESSIONAL PAPER No. 25b

APPENDIX No. 1.—Schedule of Surveyors employed and work executed by them from July 1, 1906 to March 31, 1907.—*Concluded.*

Surveyor.	Address.	Description of work.
Saint Cyr, A....	Ottawa, Ont........	Survey of the seventeenth base line across ranges 19 to 22 inclusive west of the fifth meridian, the eighteenth base line across ranges 1 to 8 inclusive west of the sixth meridian, the twenty-first base line across ranges 21 to 24 inclusive, the twenty-second base line across ranges 21 to 26 inclusive, and the eighteenth base line across ranges 20 to 22 inclusive, west of the fifth meridian.
Saint Cyr, J. B.	Ste. Anne de la Perade, Que................	Surveys of the Fort Vermilion, North Vermilion and Boyer settlements, in the Peace river district. Re-surveys in townships 6 ranges 25, 26 and 27 west of the principal meridian.
Saunders, B. J......	Edmonton, Alta	Survey of the fourth base line across ranges 13, 14 and part of 15 and the fifth base line across ranges 13 to 17 inclusive, east of the principal meridian.
Selby, H. W..	Toronto, Ont.	Subdivision in township 76 range 15, in townships 74, 75 and 76 range 16 and in townships 73, 74 and 75 range 17, west of the fifth meridian. Survey of part of the outlines of townships 73 ranges 16 and 18 and of township 75 range 15 west of the fifth meridian. Traverse of the southerly boundaries of lots in Heart River and Big Prairie Settlements, Alta.
Stewart, P. G	Britannia Bay, Ont...	Exploration survey of the country between Erwood, Saskatchewan and The Pas, Keewatin along the Canadian Northern railway right of way.
Teasdale, C. M.....	Concord, Ont.........	Contract No. 25 of 1906; subdivision of townships 9, 10 and 11 ranges 28, 29 and 30 west of the second meridian. Partial subdivision of township 10 range 4, west of the third meridian.
Thibaudeau, W.....	Ottawa, Ont.........	Exploration survey of the country lying between Fort Churchill on Hudson bay and The Pas on Saskatchewan river.
Tyrrell, J. W.......	Hamilton, Ont........	Contracts Nos. 4 and 27 of 1906; subdivision of townships 7 ranges 11, 12 and 13, township 8 range 11, and townships 16 and 17 ranges 9 and 10, all east of the principal meridian. Survey of the east outline of townships 16 and 17 range 8 and of the north outline of township 15 range 9, all east of the principal meridian.
Wallace, J. N	Calgary, Alta....	Survey of the fourteenth base line between the third and second meridians, and of the second meridian as far north as Saskatchewan river. Survey of lines to connect with "Red Earth" and "Shoal Lake" Indian reserves.
Warren, Jas	Walkerton, Ont.......	Re-surveys in townships 21 and 22 ranges 27 and 28, west of the third meridian. Retracement surveys in townships 11 and 12 ranges 25 and 26, in townships 14 ranges 19 and 30, in township 16 range 15 and in township 19 range 24, all west of the second meridian.
Watt, Geo. H......	Ottawa, Ont..........	Contract No. 8 of 1906; subdivision of townships 14 and 15 range 10, and township 14 range 9; partial subdivision of township 15 range 9, all east of the principal meridian.
Wheeler, A. O	Calgary, Alta.........	Topographer of the Department of the Interior. Phototopographical surveys from Mts. Douglas and Drummond near Red Deer river, to the Beaverfoot range.

APPENDIX No. 2.

SCHEDULE showing for each surveyor employed from January 1, 1906, to March 31, 1907, the number of miles surveyed, of township section lines, township outlines, traverses of lakes and rivers and re-survey; also the cost of same.

Surveyor.	Miles of Section Lines.	Miles of Outlines.	Miles of Traverse.	Miles of Re-survey.	Total Mileage.	Total Cost.	Cost per Mile.	By Day Work or by Contract.
						$ cts.	$ cts.	
Aylsworth, C. F.				239	239	7,143 00	29 88	Day.
Baker, J. C.	234	18	56		308	8,270 27	26 85	Contract.
Beatty, David				484	484	6,700 00	13 84	Day.
(b) Belanger, P. R. A.				48	48	5,847 72		"
Bolton, Lewis	199		26		225	6,334 00	28 15	Contract.
Bourgeault, A.	198	11	36	30	275	7,133 00	25 94	"
Bray, L. T	87	12		70	169	6,052 61	35 81	Day.
Cautley, R. W		120			120	7,528 91	62 74	"
Cautley, R. H.	192	25	58		275	7,284 00	26 49	Contract.
Christie, Wm.			142	339	481	6,825 81	14 19	Day.
Deans, W. J	201	32	20	651	904	7,023 88	7 77	"
Doupe, Jos.	4				4			"
Drummond, T.	194	24	67		285	7,586 00	26 62	Contract.
Driscoll, A	33	24	14		71	2,243 85	31 60	"
Dumais, P. T. C.	66	6			72	2,533 00	35 18	"
Edwards, Geo.	535	49			584	4,434 00	7 59	"
Fairchild, C. C.	68	12	27	3	110	5,905 48	53 69	Day.
Fawcett, T	185	12	61		258	6,956 00	26 96	Contract.
(b) Fontaine, L. E			10	73	83	8,189 09		Day.
(b) Grover, Geo. A			7	179	186	7,019 61		"
Hawkins, A. H.		18	3	305	326	5,903 66	18 11	"
Holcroft, H. S.	575	42			617	10,506 00	17 03	Contract.
Hopkins, M. W.	383	12	152		547	11,875 56	21 71	"
(b) Hubbell, E. W.				703	703	9,048 26		Day.
Jephson, R. J	16		13		29	579 00	19 97	Contract.
Johnson, A. W	61		60	17	138	12,242 97	88 72	Day.
Kirk, J. A	3		49		52	629 00	12 10	Contract.
Knight, R H.	165	2	62		229	6,462 00	28 22	"
(b) Lonergan, G. J	27	2	13	219	261	8,409 13		Day.
MacLennan, A. L.	14	6	11		31	2,816 00	90 84	"
MacLennan, A. L.	29	5	20		54	1,296 00	24 00	Contract.
McFarlane, W. G	837	6			843	10,839 00	12 86	"
McFee, A.	153	1	61		215	1,806 00	8 40	"
McGrandle, H.	79	36	6		121	3,325 00	27 48	"
(a) McMillan, Geo.			4		4	7,037 06		Day.
Michaud, A	235	8	43		286	8,184 00	28 62	Contract.
Miles, C. F	212	19	1		232	8,020 57	34 58	Day.
Molloy, John	838	60	51	12	961	27,957 00	29 09	Contract.
Montgomery, R. H	507	60	23	1	591	17,297 00	29 27	"
O'Hara, W. F	12			217	229	7,631 88	33 33	Day.
Parsons, J. L. R	697	24	104	54	879	23,458 00	26 67	Contract.
Ponton, A. W.		110			110	7,385 35	67 14	Day.
Reilly, W. R.			92	710	802	7,560 30	9 43	"
Richard, J. F.			25		25	2,000 00	80 00	"
Rinfret, R	294	63	159		516	10,320 00	20 00	Contract.
Ross, J. E.	103	16	104	28	251	7,705 79	30 70	Day.
Roy, G. P.	294	28	75		397	9,424 00	23 74	Contract.
Saint Cyr, A.		146			146	16,434 00	112 56	Day.
Saint Cyr, J. B.			106	50	156	3,951 50	25 33	"
Saunders, B. J		46			46	9,034 00	196 39	"
Selby, H. W	246	84	7		337	10,867 00	32 25	"
Teasdale, C. M	394		59		453	3,603 00	7 95	Contract.
Tyrrell, J. W.	502	30	8	24	564	17,162 00	30 43	"
Wallace, J. N.		133	6	13	152	16,764 69	110 29	Day.
Warren, Jas.			5	467	472	3,850 65	8 16	"
Watt, G. H.	90	4	2	12	108	3,222 72	29 84	Contract.
Total	9,862	1,306	1,848	4,948	17,064	435,618 32	24 72	

(a) Inspector of contract surveys. (b) Inspecting contract surveys a portion of the season.

Total cost	$435,618 32
" Mileage	17,064 00
Cost per mile	$ 24 72

APPENDIX No. 3.

List of Dominion Land Surveyors who have been supplied with Standard Measures.

Name.	Address.	Date of Appointment.	Remarks.
Austin, G. F.	Dewdney, Alta	April 14, '72	
Aylen, J.	Aylmer, Que	May 29, '85	
Aylsworth, C. F.	Madoc, Ont	" 17, '86	
Baker, J. C.	Vermilion, Alta	" 18, '06	
Barwell, C. S. W.	Dawson, Yukon Territory	Aug. 21, '94	
Bayne, G. A.	Winnipeg, Man	April 14, '72	
Beatty, D.	Parry Sound, Ont	" 14, '72	
Beatty, W.	Delta, Ont	" 14, '72	
Belanger, P. R. A.	Ottawa, Ont	May 17, '80	Topog. Surveys Branch Dept. o Interior.
Belleau, J. A.	"	" 15, '83	Topog. Surveys Branch Dept. of Interior.
Bigger, C. A.	"	Mar. 30, '82	Astronomer, Dept. of Interior.
Bolton, L.	Listowel, Ont	April 14, '72	
Boswell, E. J.	Winnipeg, Man	Feb. 18, '03	
Bourgeault, A.	St. Jean Port Joli, Que	Mar. 29, '83	
Bourgault, C. E.	" "	Feb. 21, '88	
Bourget, C. A.	Levis, Que	May 14, '84	
Bowman, H. J.	Berlin, Ont	Feb. 16, '88	
Brabazon, A. J.	Ottawa, Ont	May 12, '82	
Brady, J.	Golden, B.C	April 14, '72	
Bray, S.	Ottawa, Ont	Nov. 14, '83	Dept. of Indian Affairs.
Bray, E.	Oakville, Ont	April 14, '72	
Bray, L. T.	Amherstburg, Ont	Feb. 18, '03	
Bridgland, M. P.	Calgary, Alta	Mar. 10, '05	Topog. Surveys Branch Dept. of Interior.
Brodie, S.	Fort Qu'Appelle, Sask	April 14, '72	
Brownlee, J. H.	Victoria, B. C.	" 15, '87	
Burke, W.	Minnedosa, Man	" 14, '72	
Burnet, H.	Victoria, B.C.	June 22, '85	
Burwash, N. A.	Whitehorse, Yukon Territory	Mar. 6, '07	
Burwell, H. M.	Vancouver, B.C	Feb. 17, '87	
Carbert, J. A.	Medicine Hat, Alta	May 12, '80	
Carpenter, H. S.	Regina, Sask	Feb. 20, '01	Dept. of Public Works for Saskatchewan.
Carroll, C.	Prince Albert, Sask	April 14, '72	
Carson, P. A.	Ottawa, Ont	Feb. 22, '06	Topog. Surveys Branch Dept. of Interior.
Cautley, R. H.	Edmonton, Alta	May 1, '05	
Cautley, R. W.	"	Sept. 2, '96	
Cavana, A. G.	Orillia, Ont	Nov. 16, '76	
Charlesworth, L. C.	Edmonton, Alta	Feb. 27, '03	Dept. of Public Works for Alberta.
Christie, W.	Chesley, Ont	Mar. 22, '06	
Cleveland, E. A.	Vancouver, B.C	June 27, '99	
Côté, J. A.	Quebec, Que	May 14, '84	
Côté, J. L.	Edmonton, Alta	Mar. 21, '90	
Cotton, A. F.	New Westminster, B.C	May 11, '80	
Craig, J. D.	Ottawa, Ont	Feb. 24, '02	Boundary Surveys, Dept. of Int.
Cummings, J. G.	Calgary, Alta	" 17, '04	
Dalton, J. J.	Weston, Ont	April 17, '79	Dominion Topographical Surveyor.
Deans, W. J.	Brandon, Man	May 13, '86	
Dennis, J. S.	Calgary, Alta	Nov. 19, '77	Dominion Topographical Surveyor, Inspector of Irrigation and British Columbia Land Commissioner, C.P.R.
Denny, H. C.	"	April 1, '82	
Dickson, H. G.	Whitehorse, Yukon Territory	May 19, '89	
Dickson, J.	Fenelon Falls, Ont	April 14, '72	
Dobie, J. S.	Regina, Sask	Mar. 22, '06	Dept. of Public Works for Saskatchewan.

APPENDIX No. 3.—List of Dominion Land Surveyors who have been supplied with Standard Measures.—*Continued.*

Name.	Address.	Date of Appointment.	Remarks.
Doupe, J.	Winnipeg, Man.	April 14, '72.	
Doupe, J. L.	"	Oct. 6, '88.	Asst. Land Commissioner C.P.R.
Drewry, W. S.	New Denver, B.C.	Nov. 14, '83.	
Driscoll, A.	Edmonton, Alta	Feb. 23, '87.	
Drummond, T.	Montreal, Que.	June 24, '78.	Dominion Topographical Surveyor.
Ducker, W. A.	Winnipeg, Man.	Mar. 30, '83.	Swamp Land Commissioner.
Dumais, P. T. C.	Hull, Que.	" 29, '82.	
Edwards, Geo.	Ponoka, Alta.	April 14, '72.	
Ellacott, C. H.	Regina, Sask.	Feb. 22, '99.	
Fairchild, C. C.	Brantford, Ont.	" 20, '01.	
Farncomb, A. E.	Red Deer, Alta.	Mar. 12, '02.	
Fawcett, T.	Niagara Falls, Ont.	Nov. 18, '76.	Dominion Topographical Surveyor.
Fawcett, A.	Gravenhurst, Ont.	Feb. 22, '93.	
Fontaine, L. E.	Levis, Que.	Aug. 13, '92.	
Foster, F. L.	Toronto, Ont.	April 14, '72.	
Francis, J.	Poplar Point, Man.	June 17, '75.	
Garden, J. F.	Vancouver, B. C.	May 13, '80.	
Garden, G. H.	Lethbridge, Alta.	April 14, '72.	
Garden, C.	Winnipeg, Man.	" 14, '72.	
Gauvreau, L. P.	Riviere du Loup, Que.	" 14, '72.	
Gibbon, J.	Dawson, Yukon Territory	Feb. 12, '91.	
Gordon, M. L.	Toronto, Ont.	" 18, '04.	
Gordon, R. J.	Stirling, Alta.	Mar. 12, '02.	
Gore, T. S.	Victoria, B.C.	April 19, '79.	
Green, T. D.	Dawson, Yukon Territory	May 19, '84.	
Grover, G. A.	Toronto, Ont.	Feb. 18, '04.	
Harris, J. W.	Winnipeg, Man.	April 14, '72.	City Surveyor, Winnipeg.
Harvey, C.	Indian Head, Sask.	Feb. 17, '04.	
Hawkins, A. H.	Listowel, Ont.	Mar. 6, '06.	
Henderson, W.	Chilliwack, B.C.	Nov. 17, '83.	
Holcroft, H. S.	Toronto, Ont.	Feb. 18, '03.	
Hopkins, M. W.	Edmonton, Alta.	" 20, '01.	
Hubbell, E. W.	Ottawa, Ont.	May 19, '84.	Topographical Surv. Br., Dep. of Int. President of the D. L. S. Association.
Irwin, J. M.	Kenora, Ont.	April 14, '72.	
James, S.	Toronto, Ont.	" 14, '72.	
Jephson, R. J.	Winnipeg, Man.	May 12, '80.	
Johnson, A. W.	Kamloops, B.C.	Mar. 12, '02.	
King, W. F.	Ottawa, Ont.	Nov. 21, '76.	Dominion Topographical Surveyor, Chief Astronomer, Dept of Interior.
Kirk, J. A.	Revelstoke, B.C.	May 11, '80.	
Klotz, O. J.	Ottawa, Ont.	Nov. 19, '77.	Dominion Topographical Surveyor, Astronomer, Dept. of the Interior.
Knight, R. H.	Edmonton, Alta.	Feb. 18, '04.	
Latimer, F. H.	Detroit, Mich.	" 13, '85.	
Laurie, R. C.	Battleford, Sask.	April 27, '83.	
Lawe, H.	Ottawa, Ont.	" 14, '72.	
Lemoine, C. E.	Quebec, Que.	Mar. 31, '82.	
Lendrum, R. W.	Strathcona, Alta.	May 15, '80.	
Lonergan, G. J.	Buckingham, Que.	Feb. 28, '01.	
Lumsden, H. D.	Ottawa, Ont.	April 14, '72.	Chief Engineer Transcontinental Railway.
Macpherson, C. W.	Dawson, Yukon Territory	Mar. 7, '00.	Director of Surveys Y. T.
Magrath, C. A.	Lethbridge, Alta.	Nov. 16, '81.	Dominion Topographical Surveyor, Land Commissioner, Alberta Railway and Coal Co.
Malcolm, L.	Blenheim, Ont.	April 14, '72.	
Meadows, W. W.	Maple Creek, Sask.	Feb. 23, '05.	District Surveyor and Town Engineer.
Miles, C. F.	Toronto, Ont.	April 14, '72.	
Moberly, H. K.	Innisfail, Alta.	Feb. 27, '03.	
Molloy, J.	Winnipeg, Man.	April 14, '72.	
Montgomery, R. H.	Prince Albert, Sask.	Feb. 23, '05.	
Moore, H. H.	Calgary, Alta.	" 17, '04.	
McArthur, J. J.	Ottawa, Ont.	" 17, '79.	

SESSIONAL PAPER No. 25b

APPENDIX No. 3.—List of Dominion Land Surveyors who have been supplied with Standard Measures.—*Continued.*

Name.	Address.	Date of Appointment.	Remarks.
McColl, G. B.	Winnipeg, Man	Mar. 20, '07	
McFadden, M.	Neepawa, Man	Feb. 14, '72	
McFarlane, W. G.	Toronto, Ont	May 19, '05	
McFee, A	Innisfail, Alta.	Feb. 19, '79	
McGrandle, H.	Wetaskiwin, Alta.	May 30, '83	
McKenna, J. J.	Dublin, Ont	April 14, '72	
McKenzie, J.	New Westminster, B.C.	Nov. 18, '88	Dominion Lands Agent, New Westminster.
McLatchie, J.	Nelson, B.C	April 14, '72	
McLean, J. K.	Ottawa, Ont	" 1, '82	Dept. of Indian Affairs.
MacLennan, A. L.	Toronto, Ont.	Feb. 23, '05	
McMillan, G.	Ottawa, Ont	" 22, '06	Inspector of Surveys, Dept. of Interior.
McPherson, A. J.	Dawson, Yukon Ter.	" 21, '01	
McPhillips, G.	Windsor, Ont.	June 17, '75	
McVittie, A. W.	Blairmore, Alta.	Mar. 30, '82	
Nash, T. S.	Ottawa, Ont	Feb. 18, '04	Topographical Surveys Branch, Dept. of Interior.
Ogilvie, W.	"	April 14, '72	
O'Hara, W. F.	"	Feb. 19, '95	
Ord, L. R	Winnipeg, Man.	April 1, '82	
Parsons, J. L. R.	"	Feb. 23, '05	
Patrick, A. P.	Calgary, Alta	Nov. 19, '77	Dominion Topographical Surveyor.
Pearce, W.	"	May 10, '80	
Phillips, E. H.	Ottawa, Ont	Feb. 24, '02	Topographical Surveys Branch, Dept. of Int.; Sec.-Treas. D.L.S. Association.
Ponton, A. W.	Macleod, Alta	May 18, '81	
Proudfoot, H. B.	Saskatoon, Sask.	Mar. 28, '82	
Rainboth, E. J.	Ottawa, Ont	May 19, '81	
Rainboth, G. C.	Aylmer, Que.	April 14, '72	Boundary Surveys, Dept. of Int.
Reid, J. L.	Ottawa, Ont	" 14, '72	Dept. of Indian Affairs.
Reilly, W. R.	Regina, Sask.	Nov. 17, '81	
Richard, J. F.	Ste. Anne de la Pocatière, Que.	May 13, '82	
Rinfret, R.	Montreal, Que	Feb. 20, '00	
Ritchie, J. F.	Nelson, B.C.	Jan. 7, '89	
Robertson, H. H.	Montmagny, Que.	April 14, '72	
Roberts, S. A.	Victoria, B.C	May 16, '85	
Roberts, V. M.	Sturgeon Falls, Ont	" 17, '86	
Robinson, F. J.	Regina, Sask.	Feb. 22, '00	Dept. of Public Works for Saskatchewan.
Rombough, M. B.	Morden, Man.	April 14, '72	
Rorke, L. V.	Toronto, Ont	Aug. 13, '91	
Ross, G.	Welland, Ont	Nov. 21, '82	
Ross, J. E	Kamloops, B.C.	Feb. 12, '01	
Roy, G. P.	Quebec, Que	Nov. 17, '81	
Saint Cyr, J. B.	Ste. Anne de la Pérade, Que.	Feb. 17, '87	
Saint Cyr, A.	Ottawa, Ont	" 17, '87	
Saunders, B. J.	Edmonton, Alta.	Nov. 16, '84	
Seager, E.	Kenora, Ont	April 14, '72	
Selby, H. W.	Toronto, Ont.	Nov. 15, '82	
Sewell, H. de Q.	"	May 16, '85	
Shaw, C. A. E.	Victoria, B.C	" 10, '80	
Smith, C. C.	West Selkirk, Man.	Feb. 22, '06	
Speight, Thos.	Toronto, Ont.	Nov. 16, '82	
Starkey, S. M.	Starkey's P.O., N.S.	April 14, '72	
Stewart, G. A.	Calgary, Alta	" 14, '72	
Stewart, L. B.	Toronto, Ont	Nov. 22, '82	Dominion Topographical Surveyor; Professor of Surveying, School of Practical Science.
Stewart, E.	Ottawa, Ont.	April 14, '72	
Talbot, A. C.	Calgary, Alta	May 13, '80	
Teasdale, C. M.	Concord, Ont.	Mar. 9, '06	
Thompson, W. T.	Fort Qu'Appelle, Sask	Nov. 19, '77	Dominion Topographical Surveyor.
Tracy, T. H	Vancouver, B.C.	April 14, '72	City Engineer, Vancouver.
Tremblay, A. J.	Les Eboulements, Que.	Feb. 18, '96	
Towle, C. E.	Magog, Que.	April 14, '72	
Turnbull, T.	Winnipeg, Man.	Mar. 29, '82	

APPENDIX No. 3.—List of Dominion Land Surveyors who have been supplied with Standard Measures.—*Concluded.*

Name.	Address.	Date of Appointment.	Remarks.
Tyrrell, J. W.	Hamilton, Ont.	Feb. 16, '87.	
Vaughan, J. W.	Vancouver, B.C.	June 11, '78.	
Vicars, J.	Kamloops, B.C.	May 17, '86.	
Walker, E. W.	Regina, Sask.	Mar. 27, '07.	Dept. of Public Works for Saskatchewan.
Wallace, J. N.	Calgary, Alta	Feb. 20, '00.	
Warren, J.	Walkerton, Ont	April 14, '72.	
Watt, G. H.	Ottawa, Ont	Feb. 24, '02.	
Weekes, A. S.	Clinton, Ont	" 11, '92.	
Weekes, M. B.	Ottawa, Ont	" 18, '03.	
Wheeler, A. O.	Calgary, Alta	Nov. 21, '82.	Topographer of the Dept. of Int.
White-Fraser, G. W.R.	Ottawa, Ont	Feb. 21, '88.	Dominion Topographical Surveyor.
Wiggins, T. H.	Regina, Sask.	" 18, '96.	
Wilkins, F. W.	Norwood, Ont	May 18, '81.	Dominion Topographical Surveyor.
Wilkinson, W. D.	Toronto, Ont.	Feb. 22, '93.	
Woods, J. E.	Frank, Alta	Nov. 14, '85.	
Young, W. B.	Winnipeg, Man	Mar. 25, '05.	

APPENDIX No. 4.

List of lots in the Yukon Territory surveys of which have been confirmed from July 1st, 1906, to March 31st, 1907.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.
			GROUP No. 1.		
35	160.00	C. S. W. Barwell...	1906	Nov. 24, 1906..	Messrs. Simer, McRae, Boggs & Carlsen
36	80.00	"	1906	" 24, 1906.	" " " "
37	159.00	"	1906	" 24, 1906..	" " " "
38	20.00	"	1906	" 24, 1906..	" " " "
39	20.00	"	1906	" 24, 1906.	" " " "
			GROUP No. 2.		
265	15.80	T. D. Green........	1906	Nov. 12, 1906..	The Klondike Mines R. R. Co.
279	28.01	"	1906	July 5, 1906..	Dawson City Quartz Mining Co. Ltd.
280	45.80	"	1906	" 9, 1906..	" " " " "
296	51.52	"	1906	Oct. 19, 1906..	Peter Anderson.
297	51.65	"	1906	" 19, 1906..	" "
343	47.33	"	1906	" 30, 1906..	Mrs. M. J. Mitchell.
344	57.65	"	1906	" 30, 1906..	"
365	51.65	"	1905-06	" 19, 1906..	Mrs. L. D. Schmidt.

APPENDIX No. 5.

LIST of miscellaneous surveys in the Yukon Terrritory returns of which have been received during the nine months ending March 31st, 1907.

Year.	Surveyor.	Description of Survey.
1906	H. G. Dickson........	Reference traverse from the B. C. Boundary at Windy Arm to Carcross, at Caribou Crossing.

APPENDIX No. 6.

STATEMENT of work executed in the office of the chief draughtsman.

Returns of surveys examined:—	
Township subdivision	354
Township outline	122
Mineral claims	17
Correction and other miscellaneous surveys	256
Township plans completed for printing	451
Preliminary township plans prepared	179
Proofs of plans examined	541
Sketches made	946
Tracings and miscellaneous plans made	718
Applications for various information dealt with	1,026
Instructions to surveyors	86
Files received and returned	940
Progress sketches received and filed	630
Field books received from surveyors	365
Plans received from surveyors	169
Plans of Yukon lots received	13
Plans of miscellaneous Yukon surveys received	1
Sectional maps revised but not reprinted	5
Sectional maps revised and reprinted:—	
3 miles to 1 inch	22
6 miles to 1 inch	24
Sectional maps printed:—	
3 miles to 1 inch	2
6 miles to 1 inch	3
Sectional maps reprinted 3 miles to 1 inch	6
Declarations of settlers received and filed	382
Reference traverses drawn on group plans of Yukon Territory	1
Mineral claims reduced to 40 chains to an inch and plotted on group plans of Yukon Territory	2
Books sent to record office to be placed on record	649
Plans, other than township plans, sent to record office to be placed on record	81
Books received from record office and used in connection with office work	3,446
Books returned to record office	3,586
Volumes of plans received from record office and used in connection with office work	38
Volumes of plans returned to record office	54
Plans received from record office and used in connection with office work	372
Plans returned to record office	303

APPENDIX No. 7.

LIST of sectional maps revised, printed, reprinted, and revised and reprinted from July 1, 1906, to March 31, 1907.

1. Sectional maps revised but not reprinted:—

Port Moody.
Cypress.
Fairford.
Rosebud.
Duck Mountain.

2. Sectional maps compiled and printed.

(a) On a scale of 6 miles to 1 inch:—

Lake of the Woods.

(b) On scales of 3 miles and 6 miles to 1 inch:—

Cross Lake.
Mossy Portage.

3. Sectional maps reprinted on a scale of 3 miles to 1 inch:—

Macleod.
Blackfoot.
Rush Lake.
Rocky Mountain House.
Humboldt.
Pasquia.

4. Sectional maps revised and reprinted.

(a) On a scale of 3 miles to 1 inch:—

Wood Mountain.
Willow Bunch.
Souris.
Dufferin.
Swift Current.
Moosejaw.
Moose Mountain.
Brandon.
Bad Hills.
Yorkton.
Carlton.
Portage la Prairie.
Red Deer Forks.
Regina.
Qu'Appelle.
Riding Mountain.
Manitoba House.
Fort Alexander.
Sounding Creek.
Fort Pitt.
Shell River.
Prince Albert North.

(b) On a scale of 6 miles to 1 inch:—

Wood Mountain.
Souris.
Turtle Mountain.
Dufferin.
Emerson.
Macleod.
Moose Mountain.
Portage la Prairie.
Manitoba House.
Fort Alexander.
Sounding Creek.
Bad Hills.
Winnipeg.
Spillimacheen.
Blackfoot.
Red Deer Forks.
Rush Lake.
Regina.
Qu'Appelle.
Riding Mountain.
Yorkton.
Rocky Mountain House.
Humboldt.
Pasquia.

APPENDIX No. 8.

STATEMENT of work performed in the survey records office for the nine months ending March 31, 1907.

Files received and dealt with	5,307
Letters drafted	3,118
Reports, drafts, memos to council	......
Plans, tracings, &c., copied or compiled	315
Statutory declarations, copied and mailed	356
Plans sent to agents, registrars, &c	19,911
Pages of field notes copied	875
Prints of plans received and stored	87,112
Original plans received and recorded	657
Original field notes received and recorded	540
Letters written to agents	958
Registered parcels mailed	1,281

Work done for Topographical Surveys and other branches.

Books searched for	5,028
Books sent	3,394
Books returned	3,920
Plans searched for	1,789
Plans sent	1,421
Plans returned	514
Volumes searched for	86
Volumes sent	55
Volumes returned	45

APPENDIX No. 9.

STATEMENT of work executed in the photographic office during the nine months ending March 31, 1907.

FOR THE DEPARTMENT OF THE INTERIOR.

——	4 x 5.	5 x 7.	8 x 10.	10 x 12.	11 x 14.	16 x 18.	18 x 20.	24 x 30.	30 x 36.	36 x 42.	42 x 48.	Total.
Dry plate negatives	328	204	6	......	....	....	......	......	......	....	....	538
Bromide prints...	375	317	127	......	571	12	91	131	14	12	....	1,650
Vandyke prints....	.....	...	49	3	79	5	27	27	8	3	13	214
Silver prints	906	692	..	......	....	....	....	....	......	......	....	1,598
Photo-lithographs..	....	.....	.....	....	6	.....	648	....	.....	.....	.....	654
Wet plate negatives	....	..	66	......	82	616	94	....	......	......	..	858
Total.......	1,609	1,213	248	3	738	633	860	158	22	15	13	5,512

FOR THE GEOLOGICAL SURVEY.

——	4 x 5.	5 x 7.	8 x 10.	10 x 12.	11 x 14.	16 x 18.	18 x 20.	24 x 30.	30 x 36.	36 x 42.	42 x 48.	Total.
Dry plate negatives	30	135	.	......	....	....	....	..	....	.....	......	165
Bromide prints.. ..	.....	.....	4	....	232	6	...	......	.....	...	....	242
Silver prints	19	249	.....	....	...	.....	....	...	....	......	....	268
Wet plate negatives	.....	...	....	....	1	1	....	.....	....	....	.....	2
Total......	49	384	4	......	233	7	......	....	....	.....	..	677

APPENDIX No. 10.

STATEMENT of work executed in the lithographic office during the nine months ending March 31, 1907.

Month.	Maps.		Townships.		Forms.	
	No.	Copies.	No.	Copies.	No.	Copies.
1906.						
July	5	2,150	60	6,000	1	140
August	4	1,200	35	3,500	9	5,925
September	5	2,300	55	5,500	6	925
October	19	6,250	73	7,300	5	1,280
November	6	1,950	63	6,300	6	4,580
December	6	1,950	59	5,900	9	5,760
1907.						
January	7	3,800	105	10,500	5	2,026
February	9	6,300	55	5,500	7	824
March	3	662	35	3,500	8	3,950
Totals	64	26,562	540	54,000	56	25,410

SUMMARY OF WORK FOR THE NINE MONTHS.

—	Number of Jobs.	Number of Copies.	Number of Impressions.	Cost.	Cost per map or form.
				\$ cts.	\$ cts.
Maps	64	26,562	45,686	1,319 40	20 61
Townships	540	54,000	54,500	3,715 20	6 88
Forms, &c	56	25,460	28,670	631 40	11 27
Totals	660	106,022	128,856	5,666 00	

APPENDIX No. 11.

Names and duties of employees of the Topographical Surveys Branch at Ottawa. (Metcalfe street, corner of Slater street).

Deville, E., D.T.S., LL.D., Surveyor General.

CORRESPONDENCE AND ACCOUNTS.

Brady, M., secretary.
Hunter, R. H., accountant.
Wilkinson, Percy, assistant accountant.
Percival, M. F., stenographer and typewriter.
Cullen, M. J., stenographer and typewriter.
Pegg, A., messenger.
O'Leary, James J., messenger.

OFFICE OF THE CHIEF DRAUGHTSMAN.

Symes, P. B., chief draughtsman.
Shanks, T., B.A.Sc., D.L.S., assistant to chief draughtsman.

First Division—Instructions and General Information.

Brown, T. E., B.A., in charge of division.
Stacey, A. G., B.A., D.L.S., O.L.S.
Sylvain, J.
Green, W. T., B.A., D.L.S.
Durnford, F. G. D.
Weekes, M. B., B.A.Sc., O.L.S., D.L.S.
Mudie, J. M., Grad. R.M.C.
Carroll, M. J., Grad. S.P.S.
Cumming, A. L., B.Sc.
Seymour, H. L., Grad. S.P.S., D.L.S., O.L.S.
Umbach, J. E., Grad. S.P.S., D.L.S.
Dodge, G. B.
Burkholder, E. L.
Fitzgerald, C. C.
Kimpe, M.

Second Division—Examination of Surveyors' Returns.

Phillips, E. H., Grad. S.P.S., D.L.S., in charge of division.
Nash, T. S., Grad. S.P.S., D.L.S.
Empey, J., B.A.Sc., D.L.S., O.L.S.
Henderson, F. D., Grad. S.P.S., D.L.S.
Barber, H. G., Grad. S.P.S.
Burgess, E. L., Grad. S.P.S., O.L.S., D.L.S.
Hill, S. N., Grad. S.P.S.

Dennis, E. M., B.Sc.
Elder, A. J., Grad. S.P.S.
Morrier, J. E.
Chilver, H. L., Grad. S.P.S.
McClennan, W. D.
Cram, A. S.
Owens, R. B., B.A., B.E.
Davies, T. A., D.L.S.
Elwell, W., Grad. S.P.S.
Roger, A.
Clunn, T. H. G.
Robertson, D. F., Grad. S.P.S.
Goodall, J. N., Grad. S.P.S.
Heathcott, R. V.
Rochon, J. W.
Macdonald, J. A.
Spreckley, R. O.
Marriott, F. L.
Brice, E. E.
Smith, C. C., B.A., D.L.S., O.L.S.

Third Division—Drawing Plans for Printing.

Engler, Carl, B.A., D.L.S., in charge of division.
O'Connell, J. R.
May, J. E.
Archambault, E.
Helmer, J. D.
Moule, W. J.
Bergin, W.
Hutton, J. B.
Moran, J. F.
Villeneuve, E. J.
Brown, A.
Tremblay, A.
Ball, J. C.
Shore, S. H.
Williams, E. R.

Fourth Division—British Columbia Surveys.

Rowan-Legg, E. L., in charge of division.
Gillmore, E. T. B., Grad. R.M.C.
Lawe, H., D.L.S.
Morley, R. W.
MacIlquham, W. L., B.Sc.
Weld, W. E.
Wilson, E. E. D.
Carson, P. A., B.A., D.L.S.

Fifth Division, 185 Sparks street—Mapping.

Smith, Jacob, in charge of division.
Bégin, P. A.
Lepage, J. B.

Blanchet, A. E.
Grey, G. A.
Davies, T. E. S.
Belleau, J. A., D.L.S.
Taggart, C. H.
Perrin, V.
Smith, H. J.
Genest, P. F. X.

OFFICE OF THE GEOGRAPHER.

(Woods building, Slater street).

White, J., geographer.
Baine, H. E.
Chalifour, J. E.
Dumouchel, G. E.
Taché, H.
Darrach, M.
Wilson, H. W.
Akerlindh, A.
Anderson, W.
Blatchley, H. M.
Bennie, J.
Wood, C. G.
Craig, R. W.
Chandler, S.
Groulx, A.
Gagnon, J. S.
Inkster, F. B.
Blue, W.

SURVEY RECORDS OFFICE.

(Canadian building, Slater street).

Steers, C. J., clerk in charge.
Currie, P. W., B.A., B.Sc., D.L.S., assistant clerk in charge.
Surtees, W. S., draughtsman.
Sowter, T. W. E., draughtsman.
Smith, F. W., draughtsman.
Routh, C. F., draughtsman.
Ashton, A. W., draughtsman.
Lecourt, Eugène, draughtsman.
Moore, R. T., draughtsman.
Lambart, O. H., draughtsman and typewriter.
Belleau, Eugène, draughtsman.
Yielding, Miss A., typewriter.
Landry, Narcisse, messenger.

LITHOGRAPHIC OFFICE.

(Metcalfe street, corner of Slater street).

Moody, A., foreman.
Thicke, H., power press printer.
Bergin, J., transferrer.

Boyle, S., stone polisher.
Gagnon, J., press feeder.
Thicke, C., engraver and lithographer.

PHOTOGRAPHIC OFFICE.

(Metcalfe street, corner of Slater street).

Topley, H. N., photographer in charge.
Carruthers, H. K., photo-lithographer and photo-engraver.
Woodruff, J., photographer.
Whitcomb, H. E., photographer.
Morgan, W. E., photographer.
Kilmartin, A., photographer.
Devlin, A., photographer.
Ouimet, Geo., photographer.

GEOGRAPHIC BOARD.

(Woods building, Slater street).

Whitcher, A. H., D.L.S., secretary.

APPENDIX No. 12.

Examination Papers of the Board of Examiners for Dominion Land Surveyors.

EXAMINATION FOR ADMISSION AS ARTICLED PUPIL—LIMITED PRELIMINARY.

XVII.

February 12th, 1907.

FIRST PAPER.

	Marks.
1. Penmanship and Orthography.	50
2. The eagle weighs 258 grains, nine-tenths pure gold ; 1869 sovereigns weigh 480 ounces Troy, eleven-twelfths pure gold. Find the value of one sovereign in terms of the dollar.	6
3. A man invests \$600 in 5 per cent stocks at 120 ; at the end of the year, having just received the yearly dividend, he sells at 121½. How much better off is he than if he had loaned his money at 5 per cent per annum ?	6
4. A certain number between 10 and 100 is eight times the sum of its digits, and if 45 be subtracted from it the digits will be reversed : find the number.	6
5. The sum of the reciprocals of two consecutive numbers is $\frac{15}{56}$: find them.	7
6. Prove geometrically $a^2=b^2+c^2-2\,bc\cos A$.	7
7. Draw a straight line in a given direction so that chords cut from it by two given circles may be equal.	7
8. Find value of $(\frac{2}{3})^{\frac{1}{3}}+(\frac{3}{8})^{\frac{1}{3}}+(\frac{5}{7})^{\frac{1}{5}}+(\frac{7}{9})^{-\frac{1}{7}}$.	7
9. Find the values of x which satisfy the following equations: $5^x=\frac{1}{5}$, $10^x=23$, $13^x=117$, $3^{2x+1}=5^{3x-1}$.	7
10. Solve the equation $8^{5-3x}=12^{4-2x}$. having given log 2=·30103, log 3=·47712	7

SECOND PAPER.

	Marks.
11. Deduce the formula for the area of a triangle in terms of the three sides.	8
12. A hemisphere, a cylinder and a cone stand on the same base. If their heights are the same, compare their volumes and their areas.	9
13. Two simultaneous observations for altitude were made in the same vertical plane on a meteor at two places 3 miles apart; the respective elevations were 42° and 58°. What was the height of the meteor ?	9
14. Deduce $\tan(x+y)=\dfrac{\tan x+\tan y}{1-\tan x\tan y}$ and $\tan^2\frac{1}{2}A=\dfrac{(s-b)(s-c)}{s(s-a)}$.	9
15. Given $a=13$; $b=15$; $C=107°\ 30'$, find c.	9
16. Deduce $\tan^2\frac{1}{2}a=\dfrac{-\cos S\cos(S-A)}{\cos(S-B)\cos(S-C)}$	9
17. Given $b=99°\ 41'$; $c=100°\ 50'$; $A=65°\ 33'$; find a.	9
18. Given $a=120°$; $b=70°$; $A=130°$; find C and B.	9
19. Given $a=100°$; $b=50°$; $c=60°$; find A.	9

EXAMINATION FOR ADMISSION AS ARTICLED PUPIL—FULL PRELIMINARY.

XXIX.

February 12th to 15th, 1907.

PENMANSHIP AND ORTHOGRAPHY (PRELIMINARY AND FINAL).

Their was formally more suspishun among men than we find to-day. Sumtimes reppresentashuns were made, folowed by coershun of each indervidual.—

— Aggericultur is grately prommoated by the guvverment, so is forrestery. On the farm we see wheat, barly, oats, puttatos, terneps, carats, unnions, beens, marry-golds, sage, time, and menny other prodducks, wich when fotergraffed tugether or sepperate make a verry prittie picshur, pervided one has a good cammera.—

— In fissiks the barommeter, thermommitter, and higerommeter are importent insteraments or apperattus. Our ordernary sences are not verry accute, for, small chainges in heat are not perseptabel by them.—

— A plaice directly oppersite to ours is called antipperdease, and it would be resonible to assume that the climate their would be akseptibble to us, not too riggerous nor too troppikle. Bannaners grow well in a moist, humite atmusfere, such as one finds on the vulcannic islands in the paciffic oshun, but termattos grow better whare the air and climit are more modderit and temperrit. The appel does not devellop at all in the troppicks.—

— The eliptissity of the earth is allways eggsaggurated in a diergram, the aktual ratio of the diammaters would not make the immpresshun of an oblaite sferide.—

— Emmegrants are daly leeving Europe and immegrants are weakly arriveing in Montreal, and travule westwards to the furtle basons of the Bow and Sascatchwan rivvers, where they find good land, good watter, good skules, and good nayburs.

ARITHMETIC AND LOGARITHMS.

(Time, 3 hours.)

	Marks.
1. The discount on a note made February 27, 1906, at 3 months for \$1080 with interest at 5 per cent and discounted March 18 following was \$13.12. Find the rate of discount.	12
2. A sum of money at compound interest doubled itself in 18 years. Find the rate of interest.	12
3. How much gold 90 per cent pure must be mixed with 24 ounces 65 per cent pure so that the alloy may be 80 per cent pure?	12
4. A vessel has three taps A, B and C. By A it is emptied in 5 hours, by B in 7 hours, while C takes two-thirds as long as A and B together. In what time can the vessel be emptied by three taps together?	12
5. The logarithm of the product of two consecutive numbers is 2.4857214. Find the numbers.	13
6. Find value of $(\frac{1}{2})^{\frac{1}{5}} - (\frac{2}{3})^{-\frac{1}{2}} + (\frac{7}{8})^{\frac{2}{3}} - (\frac{5}{7})^{-\frac{1}{4}}$	13
7. Find angle, the logarithm of its sine being 9.6234562. " " tangent being 0.2345678n. " " secant being 0.3148923n.	13
8. Find logarithmic value for sin 92° 13′ " " cos 104° 15′ " " tan 85° 17′	13

ALGEBRA.

(Time, 3 hours.)

Marks.

1. Find the L. C. M. of $x^2-10x+24$; $x^2-8x+12$, and x^2-6x+8; and the H. C. F. of $6x^2-13x+6$; $2x^2+5x-12$, and $6x^2-x-12$. 12
2. Two-thirds of *A's* money is equal to *B's*; and three-fourths of *B's* is equal to *C's*; together they have $650. How much has each? 12
3. Solve $\frac{3x-1}{2} - \frac{y}{4} = \frac{7}{2}$; $x+3y=9$. 12
4. Find a fraction which becomes $\frac{1}{2}$ on subtracting 1 from the numerator and adding 2 to the denominator, and reduces to $\frac{1}{3}$ on subtracting 7 from the numerator and 2 from the denominator. 12
5. Solve $\frac{21x^3-16}{3x^2-4} -7x=5$. 13
6. Solve $x^2y^2 - 6x = 34 - 3y$; $3xy + y = 2\ (9 + x)$. 13
7. Expand $(x + y)^5$ and $(x + y + z)^3$. 13
8. A person selling a horse for $72, finds that his loss per cent is one-eighth of the number of dollars that he paid for the horse. What was the cost price? 13

PLANE GEOMETRY.

First Paper.

(Time, 3 hours.)

Marks.

1. When in a triangle $a^2 + b^2 = c^2$ prove that C is a right angle. 12
2. The straight lines which bisect the angles of a triangle meet in a point. 12
3. Find the side of a square equal to a given rectangle. 12
4. Construct a rectangle equal to a given square such that the difference of two adjacent sides shall be equal to a given straight line. 12
5. Similar arcs of circles which have equal chords, are equal. 13
6. Inscribe a circle in a given triangle. 13
7. Describe a circle to touch a given circle and two given tangents to the circle. 13
8. Prove that the locus of a point whose distance from one of two fixed points is double that from the other, is a circle. 13

PLANE GEOMETRY.

Second Paper.

Marks.

(Time, 3 hours.)

9. Prove geometrically $(a-b)^2 + 4\,ab = (a+b)^2$. 12
10. The locus of the middle points of all chords drawn through a fixed point in a circle, is a circle. 12
11. Describe a circle about a given triangle. 12
12. Show how to cut off the corners of an equilateral triangle so as to leave a regular hexagon. 12

13. If an angle of a triangle be bisected by a straight line which cuts the opposite side, the rectangle contained by the segments of that side is less than the rectangle contained by the other sides by the square on the line. 13
14. Similar triangles are to one another in the ratio duplicate of the ratio of two corresponding sides. 13
15. Bisect a given triangle by a line parallel to its base. 13
16. If an angle of a triangle be bisected internally or externally by a straight line which cuts the opposite side or that side produced, the ratio of the segments of that side is equal to the ratio of the other sides of the triangle. 13

PLANE TRIGONOMETRY.

Marks.

(Time, 3 hours.)

1. Prove that $\sin (A - B) = \sin A \cos B - \sin B \cos A$. 12
2. Prove that $\tan (A - 45°) = \dfrac{\tan A - 1}{1 + \tan A}$ 12
3. Prove that $\dfrac{\sin 3A}{\sin A} - \dfrac{\cos 3A}{\cos A} = 2$. 12
4. Show that $\sin \dfrac{A}{2} = \sqrt{\dfrac{(s-b)(s-c)}{bc}}$. 12
5. Given $a = 31 \cdot 24$, $b = 49 \cdot 00$, $A = 32° \ 18'$, find c. 13
6. Given $a = 6 \cdot 24$, $b = 2 \cdot 35$, $C = 110° \ 32'$, find A. 13
7. Given $A = 50° \ 39'$; $B = 60° \ 07'$; $a = 412 \cdot 67$, find c. 13
8. Given $a = 13$; $b = 12$. $c = 5$,. find C. 13

SPHERICAL TRIGONOMETRY.

(Time, 3 hours.)

Marks.

1. Prove $\cos a = \cos b \cos c + \sin b \sin c \cos A$. 14
2. Deduce $\cos^2 \frac{1}{2} A = \dfrac{\sin s \sin (s-a)}{\sin b \sin c}$ 14
3. State and prove Napier's rules for the solution of right-angled spherical triangles. 14
4. given $c = 140°$, $a = 20°$ $C = 90°$, solve the triangle. 14
5. Given $b = 99° \ 41'$, $c = 100° \ 50'$, $A = 65° \ 33'$, find a. 14
6. Given $A = 135° \ 05'$, $C = 50° \ 30'$; $b = 69° \ 35'$, find B. 15
7. Given $A = 120°$, $B = 130°$; $C = 80°$ find c. 15

MENSURATION OF SUPERFICIES.

(Time, 3 hours.)

Marks.

1. The sides of a field are 7·84 ch., 9·32 ch. and 10·56 ch., find its area. 14
2. What parallels of latitude would divide the surface of the earth into three equal areas? 14
3. If the surface of a sphere is changed to that of a tetrahedron, what is the edge of the latter? 14

4. How many yards of canvas are required for a bell (conical) tent 12 ft. high, 10 ft. in diameter and having a 3-foot wall? 14
5. What is the area of the regular pentagon inscribed in the circle whose radius is 10 ? 14
6. If in question 1 the chain was 5 inches too long what is the true area of the field ? 15
7. What is the area of a triangle where

   $a = 14.68$ ch., $b = 17.32$ ch., and $C = 57° 42'$? 15

Examination for Commission as Dominion Land Surveyor.

XXXVII.

February 12th to 19th, 1907.

ALGEBRA.

(Time, 3 hours.)

Marks.

1. Find the *H. C. F.* of $24\,a^3\,b^2\,c^3$, $16a^3\,b^4\,c^2$, $40a^2\,b^3\,c^5$,
   And the *L. C. M.* of $x^3 - 15ax^2 + 48a^2\,x + 64a^3$, and $x^2 - 10ax + 16a^2$. 11
2. Find the value of

$$\frac{1}{8-8x} - \frac{1}{8+8x} + \frac{x}{4+4x^2} - \frac{x}{2+2x^4}$$ 11

3. A regiment has food for m days; but if it were reinforced by p men, would have food enough for n days only. Find the number of men in the regiment. 11
4. A certain number between 10 and 100 is eight times the sum of its digits, and if 45 be subtracted from it the digits will be reversed; find the number. 11
5. Find the square root of $16x^6 + 16x^7 - 4x^8 - 4x^9 + x^{10}$ 11
6. Solve $\dfrac{21x^3 - 16}{3x^2 - 4} - 7x = 5.$ 11
7. Solve $\dfrac{1}{x^3} - \dfrac{1}{y^3} = 91;\ \dfrac{1}{x} - \dfrac{1}{y} = 1.$ 11
8. Find a number whose square diminished by 119 is equal to ten times the excess of the number over eight. 11
9. If a train travelled 5 miles an hour faster it would take one hour less to travel 210 miles; what time does it take? 12

PLANE GEOMETRY.

(Time, 3 hours.)

Marks.

1. Two parallelograms, which have two sides equal and in a straight line, and also have the sides opposite to the equal sides in a straight line, are equal. 15
2. The straight lines, drawn from the vertices of a triangle perpendicular to the opposite sides, meet in a point. 15
3. Prove geometrically $(a + b)^2 = a^2 + 2ab + b^2$. 15

4. The sum of the squares on the sides of a parallelogram is equal to the sum of the squares on the diagonals. 15
5. Find the side of a square equal to a given rectangle. 15
6. The largest rectangle, the sum of whose sides is given, is a square. 15
7. Angles in the same arc of a circle are equal. 15
8. The locus of a point at which a given straight line subtends a constant angle is an arc of a circle. 15
9. To inscribe a regular polygon of fifteen sides in a circle. 15
10. Prove that the bisectors of all the angles of any regular polygon meet in a point. 15

SOLID GEOMETRY.

(Time, 3 hours.)

Marks.

1. Only one straight line can be drawn through a given point at right angles to a given plane. 8
2. Two intersecting planes cannot both be at right angles to the same straight line. 8
3. The sum of any two plane angles of trihedral angle is greater than the third angle. 8
4. The sum of the plane angles of any convex polyhedral angle is less than four right angles. 8
5. Describe a sphere about a given tetrahedron (not regular). 8
6. What are the linear dimensions of a sphere, cube, and equilateral tetrahedron having the same volume ? 8
7. What are the dimensions when the solids in the above question have the same surface? 9
8. The axes of an oblate spheroid are 12 and 20. What is its volume ? 9
9. What is the volume of a prismoid, the length and breadth of its greater end being 24 and 16 inches, those of its top 16 and 12 inches, and its length 120 inches? 9

SPHERICAL TRIGONOMETRY.

(Time, 3 hours.)

Marks.

1. Show that $\cos a \sin b = \sin a \cos b \cos C + \sin c \cos A$. 15
2. Deduce $\sin \frac{1}{2} a = \sqrt{\frac{-\cos S \cos (S-A)}{\sin B \sin C}}$. 15
3. Deduce $\tan \frac{1}{2} (a-b) = \frac{\sin \frac{1}{2} (A-B)}{\sin \frac{1}{2} (A+B)} \tan \frac{1}{2} c$. 15
4. Find the area of a spherical triangle 15
5. Given $A=100°$, $a=112°$, $C=90°$, solve the triangle. 15
6. Given $b=98° \ 02'$, $c=80° \ 36'$, $A=10° \ 16'$, find a 20
7. Given $a=40° \ 16'$, $b=47° \ 44'$. $A=52° \ 30'$, find B. 15
8. Given $a=100°$, $b=50°$, $c=60°$, find A. 15

MEASUREMENT OF AREAS (FIRST PAPER).

(Time, 3 hours.)

Marks.

1. To cut off from a quadrilateral any given portion by a line drawn from one of its angles. 16
2. To divide a triangle into two given parts by a straight line passing through a given point within the triangle. 16
3. In the triangle ABC, $AB = 14$ch, $BC = 13$ch, $CA = 15$ch. It is required to bisect it by a straight line running from BC to AB and making an angle of 60° with BC. What is the length of the dividing line? 16
4. If the northern hemisphere were covered with an ice-cap five miles thick, from the north pole to latitude 40°, when melted what depth of water would this give when spread over the whole earth, radius 4,000 miles, density of ice ·9 ? 17
5. The half-mile line of a half-mile race track is composed of two equal tangents and of two equal circular arcs, the radius is 200 feet. What is the area enclosed by the half-mile line? 18
6. How many acres are included between the parallels of 49° and 50° and between the meridians 100° and 101° ? 17

MEASUREMENT OF AREAS. (SECOND PAPER.)

Marks.

(Time, 3 hours.)

7. The notes of a survey of a piece of land are as follows :—

					CH
1.	N.	34°	15′	E.	2·73
2.	N.	85	00	E.	1·28
3.	S.	56	45	E.	2·20
4.	S.	34	15	W.	3·53
5.	N.	56	30	W.	3·20

40

Required, the area after first balancing the survey.

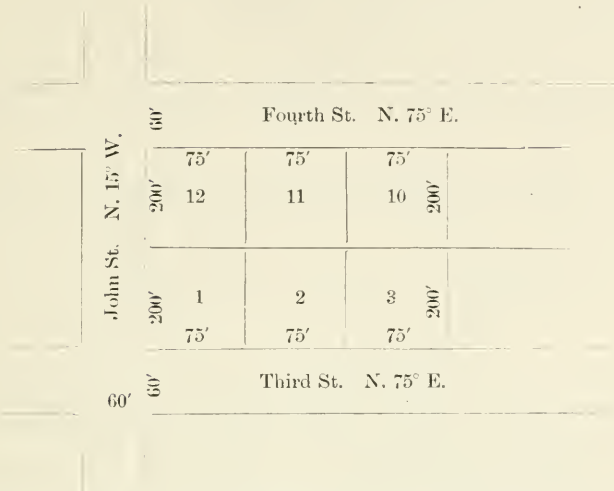
8. (*a*) Express the conditions necessary for a closed survey by two equations.
   (*b*) Show what missing data may be supplied and whether any ambiguity may arise.
   (c) How does the supplying of missing data affect balancing the survey? 20
9. Deduce the method of computing areas by 'latitude and departure.' 20
10. If in question 7 the azimuth of every course is in error 30′, and a re-survey of the area were made with the proper azimuths beginning at the fixed point 1, what displacement in latitude and departure would station 3 suffer ? 20

DESCRIPTIONS.

(Time, 3 hours.)

Marks.

1.



The above is part of the registered plan of the town of Holly, in the county of Tweed and province of Alberta. A sells to B a part of Lot No. 1, and adjoining John and Third streets. The part sold is to have a frontage of forty feet on Third street, to extend to the rear of the lot, and the dividing line to be parallel to John street. Make a description for a deed. 25

2. Using the plan of question 1. Supposing A to own lots Nos. 1 and 2, he sells Lot No. 2 to B and gives the right of ingress and egress to B by a lane, 16 feet wide, running along the whole of the rear limit of Lot No. 1. Make the necessary description for the conveyance. 25

3. Moose Creek flows across the N.E. ¼ Sec. 12, Tp. 13, R. 15 W., in an easterly direction. B desires to buy the northerly part of the quarter section lying north of the creek together with the creek. From measurement the southerly bank of the creek intersects the eastern and western quarter section lines respectively at 22·12ch and 20·18ch from the northern quarter section line. The whole area to be conveyed is supposed to contain 85 acres. Make a description for a deed. 25

4. Make a description for the remaining part of the quarter section given in question 3. 25

ASTRONOMY. (FIRST PAPER.)

(Time, 3 hours.)

Marks.

1. (a) Define sidereal, mean, solar, and standard time.
   (b) When from an observed altitude of the sun at a given place we deduce the hour angle in degrees and then convert this into time, what kind of time is it? Why?
   (c) When similarly from an altitude of a star we compute the hour angle, what kind of time is it? Why? 13
2. Explain fully the equation of time, and show how and why it varies during the year, and that it vanishes four times a year. 13
3. What are the least and greatest values that the azimuth of Polaris at greatest elongation can have, and what are the respective latitudes? 13

4. What is the standard time of greatest elongation (eastern) of Polaris in February 15, 1904, in latitude 45° 25′ N. longitude 75° 43′ W. ? 13
5. What is the sidereal time of rising of Arcturus (a=14^h 11^m 29^s, δ=+19° 40′) on same date and place as in above question ? 12
6. On same date as above the observed altitude of Arcturus on the prime vertical was 72° 13′. What was the latitude of the place ? 12
7. On same date as above the observed meridian altitude of Arcturus measured from the north horizon was 70° 20′. What was the latitude of the place ? 12
8. On July 2, 1904, in longitude 110° W., the meridian altitude of the upper limb of the sun at lower or northern culmination was 9° 47′. What was the latitude of the place? 12

ASTRONOMY. (SECOND PAPER.)

Marks.

(Time, 3 hours.)

9. On June 21, 1904, at the township corner T. IV, V, R. V, VI, W. of 2nd M. at watch-time 8^h 15^m 30^s the observed altitude of the sun was 32° 16′. What was the azimuth and watch correction ? 17

10. In the above question what was the right ascension of a star which crossed the meridian at the time of observation of the sun? 17

11. At the place in question 9, a pocket sidereal chronometer is fast on local sidereal time 8^m 17·3^s, and has a daily losing rate of 4·5^s. Ten days later on the same base line the chronometer was found to be fast 10^m 32·5^s. What was the exact position with reference to section corner, of the latter place of observation? 17

12. The difference of meridian zenith distance between Arcturus and Polaris at lower transit was 35° 09′. What was the latitude of the place. δ'= 88° 49′, δ = 9° 40′? 17

Is there any ambiguity ?

13. What is the standard time of sun-rise at date and place in question 9? 16

14. What was the local mean time on June 21, 1904, when the shadow of a picket at Sec. 3-4, Tp. IV-V, R. V-VI, W. of 2nd M. fell on the base line ? 16

MANUAL OF SURVEY. (FIRST PAPER.)

Marks.

(Time, 3 hours.)

1. Define an initial meridian, a base line, and a correction line. Where are the initial meridians? How is the deficiency or surplus in surveyed lines disposed of? 20
2. Describe the different kinds of posts, mounds, pits and trenches used in the present system of survey. Show how and where they are placed. 20
3. How would you mark the following posts:
   (*a.*) At the corner between Sections 13, 14, 23 and 24, Tp. 57, R. 21, east of the P.M.
   (*b.*) At the south corner between Sections 31 and 32, Tp. 50, R. 7, W. of the 3rd M.
   (*c.*) At the N. E. corner of Section 17, Tp. 42 A., R. 1, W. of 3rd M. (on the south side of the road allowance dividing two systems of survey.)
   (*d.*) At the south corner of Tp. 51 between ranges 18 and 19, W. of 4th M.
   (*e.*) At the witness mound placed at a distance of 6 chains west of the N. W. corner of Section 25, Tp. 15, R. 22, W. of the 3rd M. 20

4. How is a settlement surveyed? Give the rules to be observed in measuring a distance by means of a triangle. 20
5. Define a bearing and an azimuth. To what meridian is a bearing referred in subdividing a township and how is it deduced from an observed azimuth? 20

MANUAL OF SURVEY. (SECOND PAPER.)

Marks.

(Time, 3 hours.)

6. How are the north and the south boundaries of a township surveyed? When is a quarter section considered sufficiently surveyed for disposal? What are the limits of error allowed in a subdivision survey? 20
7. What is to be entered in the report made by a surveyor on the subdivision of a township? What is the date of a survey? 20
8. What are the bodies of water in a township which have to be surveyed, and what are those which are not to be surveyed?
   In what manner is a traverse made?
   Give the rules governing the rights of riparian owners. 20
9. Define, a resurvey, a retracement survey, a restoration survey, an obliterated monument and a lost monument. Give the rules governing the above surveys. Under what circumstances is a subdivider justified in resurveying or retracing a township outline? 20
10. All the section and quarter section corners around section 34, Tp. 58, and section 3, township 59, range 13, W. of 2nd M. are lost, but the positions of the adjoining corners are known. How would you proceed to re-establish the lost corners? 20

EXAMINATION FOR CERTIFICATE AS DOMINION TOPOGRAPHICAL SURVEYOR—SUPPLEMENTAL.

X

February 12th to 15th, 1907.

ALGEBRA.

Marks.

(Time, 3 hours.)

1. Find the number of (1) three digits, (2) of four digits in the denary scale such that if the first and last digits be interchanged the result represents the same number in the nonary scale, and prove that there is only one solution in each case. 8
2. The whole number next greater than $(3+\sqrt{5})^n$ is divisible by 2^n. 7
3. If on an average one vessel in every ten is wrecked, find the chance that out of 5 vessels expected, 4 at least will arrive safely 7
4. The number of ways in which p things may be distributed among q persons so that everybody may have one at least is
$$q^p - q\,(q-1)^p + \frac{q\,(q-1)}{\underline{/2}}\,(q-2)^p \,\ldots\ldots\ldots\ldots\ldots\ldots \qquad 7$$
5. Show that if $a, b, c, d,$ be four positive unequal quantities and $s = a+b+c+d$ then $(s-a)\ (s-b)\ (s-c)\ (s-d) > 81\ abcd.$ 7

6. Solve the equation

$$\sqrt{x+27}+\sqrt[4]{55-x}=4. \qquad 7$$

7. In a shooting competition a man can score 5, 4, 3, 2, or 0 points for each shot: find the number of different ways in which he can score 30 in 7 shots. 7

PLANE TRIGONOMETRY.

Marks.

(Time, 3 hours.)

1. If $\phi=\frac{\pi}{13}$ show that

$$\cos\phi+\cos 3\phi+\cos 9\phi=\frac{1+\sqrt{13}}{4}$$

and $$\cos 5\phi+\cos 7\phi+\cos 11\phi=\frac{1-\sqrt{13}}{4} \qquad 9$$

2. Having given the equation

$$\frac{\cos\alpha}{\cos\theta}+\frac{\sin\alpha}{\sin\theta}=-1$$

prove that

$$\frac{\cos^3\theta}{\cos\alpha}+\frac{\sin^3\theta}{\sin\alpha}=1. \qquad 8$$

3. If $\sin A$, $\sin B$, $\sin C$, be in harmonical progression so also will be $1-\cos A$, $1-\cos B$, $1-\cos C$. 8

4. Sum the following infinite series, and the corresponding series in sines: $\cos\theta+\frac{1}{2}\cos 2\theta+\frac{1}{3}\cos 3\theta+\ldots\ldots$ 8

5. Demonstrate Euler's formulæ:

$$\cos x=\tfrac{1}{2}\left(e^{x\sqrt{-1}}+e^{-x\sqrt{-1}}\right)$$

$$\sin x=\frac{1}{2\sqrt{-1}}\left(e^{x\sqrt{-1}}-e^{-x\sqrt{-1}}\right) \qquad 8$$

6 Develop the sine and cosine of the multiple angle in a series of ascending powers of the cosine of the simple angle. 9

ANALYTICAL GEOMETRY.

(Time, 3 hours.)

Marks.

1. An ellipse and a parabola have a common focus, and the other focus of the ellipse moves on the directrix of the parabola. Show that the points of contact of a common tangent subtend a right angle at the common focus. 10
2. (*a*) Find the equation of the evolute of the common parabola.
   (*b*) Show that a (produced) normal to an involute is tangent to the evolute, the point of tangency is the centre of curvature and consequently the normal thus produced is the radius of curvature. 10

3. (*a*) Determine the asymytotes of the locus $x^3 - xy^2 + ay^2 = 0$ by developing $y = f(x)$
   (*b*) Produce the formulae for passing from a polar to a rectangular system of co-ordinates. 10
4. (*a*) Produce the polar equation of a conic section.
   (*b*) What is the polar equation of an ellipse whose axes are 12 and 8, the pole being at the focus? What are the focal distances? 10
5. Two tangents TP, TQ to an ellipse meet any other tangent P[1] Q[1], prove that $PP^1 \cdot QQ^1 = TP^1 \cdot TQ^1 \cos^2 \frac{a - \beta}{2}$; where a and β are the eccentric angles at P, Q. 13
6. The equation of the straight lines which pass through the origin and make an angle a with the straight line $x + y = 0$ is $x^2 + 2xy \sec 2a + y^2 = 0$. 12
7. (*a*) The eccentric angles of the vertices of conjugate diameters differ by 90°.
   (*b*) Any chord which passes through the focus of an ellipse is a third proportional to the transverse axis and a diameter parallel to the chord. 10

THEORY OF LIMITS AND DIFFERENTIAL CALCULUS.

Marks.

(Time, 3 hours.)

1. Define 'limit.' 3
2. Prove geometrically that the area of a circle is equal to that of the regular circumscribed or inscribed polygon, in the limit when the number of sides of the polygon is indefinitely increased. 10
3. In a triangle $A\ B\ C$, a point D is taken in AB, and a point E in AC produced, CE being m times BD. Find the point of ultimate intersection of BC and DE, when BD and CE are indefinitely diminished retaining always the same ratio to one another. 10
4. Find the volume of the portion of a paraboloid of revolution included between the vertex and a plane perpendicular to the axis and at a given distance from the vertex. (A geometrical solution will be preferred). 10
5. Differentiate

$$\tan^{-1}\frac{x}{a}\ ; \quad (\cos x)^{\cos x}\ ;$$

$$\cos^{-1} e^{ax} - e^{-ax}.$$ 9

6. Expand in ascending terms of x to five terms

$$x\ e^{-a^2x^2} \cos r\ x.$$ 9

7. Given two sides a and b of a spherical triangle find the variation in the side c and the angles A and B due to a small variation of the angle C. 10
8. With the data of the last question express A in a series in terms of a, b and C when the angle B is very nearly a right angle. 14

GEODETIC SURVEYING.

(Time, 3 hours.)

Marks.

1. Deduce the formula for reducing a base line to sea-level. 20
2. Deduce the formula for the effect of a deflection of the plumb-line upon an observed azimuth. 20
3. Given the pull, length and weight of a tape, deduce the formula of the correction for sag. 20
4. Describe a modern base line apparatus for primary triangulation and its use. 20
5. How would you run between two points of the same observed latitude a line having the curvature of the parallel of said latitude. Deduce the formulæ. 25
6. Find the difference of altitude of two stations from their reciprocal zenith distances, assuming the refraction to be equal for both. 25
7. Deduce a formula for the ellipticity of the earth from the length of the seconds pendulum at two places. 25
8. Having observed the angles between three known points from a fourth point deduce a formula for the distance of the fourth point from each of the others. 25
9. Given the latitude of a place find the radius of curvature along a given azimuth. 20

ASTRONOMY. (FIRST PAPER.)

(Time, 3 hours.)

Marks.

1. From the following ephemeris of the moon:

Mar. 3, 12^h R.A.	20^h	28^m	$17^s{\cdot}88$
4, 0	20	58	57 ·08
4, 12	21	29	02 ·01
5, 0	21	58	28 ·39
5, 12	22	27	15 ·43
6, 0	22	55	25 ·50
6, 12	23	23	03 ·39

find the difference of the moon's right ascension in one minute for March 5, 0^h. 17

2. To find the parallax of a star in zenith distance and azimuth when the apparent zenith distance and azimuth are given, the earth being regarded as a spheroid. 17
3. In the method of observing for time by an observation of Polaris and of a time star in the same vertical, as given in the Manual of Dominion Lands, show the derivation of the formula of p (the arc of a great circle from the pole perpendicular to the above vertical)$=P\sin(t-t') + \frac{P^2}{2}\sin 2(t-t')\tan\delta +$. 17
4. If a, a′ are the hour angles in degrees of the sun at Greenwich at t and t′ hours mean time, deduce the equations of time at the preceding and following mean noons, expressed in fractions of an hour. 17
5. Find the R.A. of the sun at true noon on October 8, 1906, given that the equation of time for that day is—12^m 13^s, and that the sidereal time of mean noon on March 21 was 23^h 52^m 22^s. 16
6. On February 19, 1906, in latitude 45° 25′ N., longitude 75° 42′ W., what is the standard time when α and β Orionis are in the same vertical plane?

   $\delta\,\alpha = 7°\ 23'$ N. $\quad a\,\alpha = 5^h\ 50^m$

   $\delta\,\beta = 8°\ 19'$ S. $\quad a\,\beta = 5^h\ 10^m$ 16

ASTRONOMY. (SECOND PAPER.)

(Time, 3 hours.)

7. In Talcott's method for latitude deduce the formula for reduction to the meridian:

(1) When the line of collimation of the telescope is off the meridian, the instrument having been revolved in azimuth and the star observed at the hour angle T near the middle thread, then

$$M = \frac{2 \sin^2 \frac{1}{2} T}{\sin 1''} \cdot \frac{\cos \phi \cos \delta}{\sin \xi}$$

(2) When the star is observed off the line of collimation, the instrument remaining in the plane of the meridian, then

$$M = \frac{2 \sin^2 \frac{1}{2} T}{\sin 1''} \cdot \tfrac{1}{2} \sin 2\delta$$ 16

8. (*a*) In determining equatorial intervals of threads by stars within 10° of the pole, deduce the formula

$$(i_n = (t_n - t) \cos \delta \sqrt[3]{\cos T_n})$$

where T_n is the hour angle of the star for the respective threads.

(*b*) Give formulae for level constant including inequality of pivots when angle of the V of the level is not the same as of V of the transit. 16

9. As a ship starts from Liverpool its chronometer indicates 0^h and is correct by Greenwich mean time. After 16 days, as it reaches Quebec the chronometer indicates $7^h\ 00^m\ 23^s$, and Quebec time is $2^h\ 05^m\ 42^s$. Nearly 7 days afterwards the ship departs at Quebec noon, the chronometer then reading $4^h\ 54^m\ 39^s$; and when it reaches Liverpool after a voyage just over 14 days it is found to be 17^s slow by Greenwich mean time. What is the longitude of Quebec? 17

10. Deduce the general formula (Mayer's) for the transit instrument in the meridian

$$T = a\frac{\sin(\phi-\delta)}{\cos\delta} + b\frac{\cos(\phi-\delta)}{\cos\delta} + \frac{c}{\cos\delta}$$

11. Deduce the formula for finding the latitude from the observed transits (a number of threads) over the prime vertical, east and west of the meridian, when the instrument is reversed at each transit between the observations of the star on opposite sides of the prime vertical (Struve's method). 17

12. (*a*) At sidereal time t the zenith distance of a given star is ζ and at time t^1 the zenith distance is ζ^1. Find the latitude and express it in terms of the data.

(*b*) On March 24 at noon the sun's declination was 1° 29′ 05″.1 and the difference of right ascension of the sun and a star $6^h\ 01^m\ 54^s{\cdot}45$. On September 18 following at noon the sun's declination was 1° 49′ 30″·2, and it was distant from the star $5^h\ 27^m\ 32^s{\cdot}97$ in right ascension. On September 19 at noon the sun's declination was 1° 26′ 12″·8, and it was distant from the star $5^h\ 31^m\ 08^s{\cdot}3$ in right ascension. Find the right ascension of the star and that of the sun at the first observation. 17

THEORY AND USE OF INSTRUMENTS.

(Time, 3 hours.)

	Marks.
1. Describe a modern form of level instrument for geodetic levelling.	20
2. Explain the different methods in use for the determination of the collimation of an astronomical transit.	15
3. Describe Ramsden's and Huyghen's eye-pieces. How are the diaphragm threads illuminated for nadir observations with a mercurial horizon?	15
4. How would you investigate the figure of the pivots of an astronomical transit?	20
5. Describe the Kew Dip Circle and its use for the determination of inclination and intensity.	20
6. Explain why temperature affects the rate of a watch and how its effect is corrected. If you wish to make your chronometer run faster or slower without altering its temperature compensation, which of the balance screws will you turn?	15
7. How do you explain the large errors in heights measured with an aneroid as compared with measurements by the mercurial barometer?	15
8. Define isobars and their connection with the direction of the wind in the northern hemisphere. Define relative humidity and dew-point.	15
9. Convert Fahrenheit's degrees to Centigrade and Reaumur.	15

REPORTS OF SURVEYORS

GENERAL REPORTS OF SURVEYORS
1906-1907

APPENDIX No. 13.

REPORT OF C. F. AYLSWORTH, JR., D.L.S.

SURVEYS AND RESURVEYS IN EASTERN MANITOBA.

Madoc, March 13, 1907.

E. Deville, Esq., LL.D.,
Surveyor General,
Ottawa.

Sir,—I have the honour, in accordance with my instructions dated April 17, 1906, to submit the following general report on my survey operations during the season of 1906.

I left home on Monday, April 23, after having returned from Kingston, where I interviewed several young gentlemen of Queen's University with whom you instructed me to consult previous to their joining my party.

I arrived in Winnipeg on April 29, and immediately proceeded to organize a party and purchase my supplies. The labour question is the burning one of the west, as men are not at all obtainable in proportion to the demand. It is therefore very difficult to organize a satisfactory party; and I was occupied in this for several days. But after getting the party organized and having the outfit delivered at Beausejour, we all left Winnipeg for that place on Friday, May 4. We arrived there at noon, got the outfit unloaded and tents up and began the surveyor's usual life. We were engaged for a few days in putting the outfit in order. Beausejour is an old friend of mine, having been engaged in surveys there during the year 1900 for ten months. I found the town has progressed most remarkably since that time; there were general stores in abundance; a chartered bank, churches, hotels, lawyers, doctors, real estate agents and one of the most attractive schools in the province of Manitoba (constructed of cement blocks) and also all the necessary tradesmen the surrounding country and town requires.

While I was there a company was organized to construct, equip and operate a glass factory. The peculiar quality of the sand in the district is especially adapted to the manufacture of glass. This, of course, will be a very great boon to Beausejour if the experiment proves successful. The factory is built right on top of the sand required to manufacture the glass and the sand is there in unlimited quantities. This gives the company an immense advantage. I remember about thirty years ago a factory was built and operated for a time in the town of Napanee, Ontario, but the disadvantage there was that the owners were compelled to transport the suitable sand for glass making purposes from Brockville, Ontario, and on account of sundry other handicaps they could not manufacture glass in Napanee within twenty per cent of the price of the glass imported into and sold in Canada. The gentlemen comprising the Beausejour glass enterprise are all Germans, who come from the country where glass is successfully manufactured and where glass-blowers are trained to perfection. The company seems to be erecting a good class of buildings and have such confidence in the future success of their venture that they are making a large outlay of capital. Another industry that has been started there and whose output of goods cannot cope with the demand is a cement block equipment. These blocks when utilized in the construction of buildings are permanent, and present an especially attractive appearance. Then again, they are manufacturing a very superior quality of steam-dried white brick.

The development of the agricultural resources of the Beausejour district is as yet in its initial stage. North, south, east and west of the town, the farmers, generally speaking, are Galicians, Poles, Bohemians, Russian-Germans and Germans of a very industrious type. In fact the district through which I was operating last season is very thickly settled. In many cases the quarter sections are divided into legal subdivisions of forty acres each, and each legal subdivision is occupied. These people have not as yet begun the production of wheat for the market, confining themselves merely to the clearing and fencing of their farms and building for themselves comfortable houses. As a result there has been no demand as yet for elevators in Beausejour. The main travelled road leading north from that town between ranges 7 and 8 is so closely settled that it resembles a trip through the suburbs of a city. Their dwellings present a neat and attractive appearance, the windows being decorated with curtains and flowers. The people take a deep interest in the education of the rising generation ; their schools are numerous and well patronized. They also look diligently after their religious and spiritual welfare by providing attractive, commodious and substantial places of worship. From Beausejour northerly for a distance of twelve miles, there are no less than three churches, located as follows :—One on section 7, township 14, range 8 ; one on section 18, township 14, range 8, and another on section 6, township 15, range 8. In addition to the services held in these attractive edifices, services are conducted in the different schoolhouses throughout the district. These numbered four or five, so that there was no reason why the members of my party should not have good and proper religious disciplining.

In townships 13, 14 and 15, ranges 7 and 8, in the neighbourhood of one hundred and fifty thousand dollars has been expended within the last two years for drainage purposes and the cost assessed against the adjoining lands. The material from the ditches has been thrown up and formed into a road-bed and nearly all the roads have thus been assisted, and rendered in a manner passable, except in those portions of the townships lying east of Brokenhead river. In this portion not nearly so many miles of drainage have been constructed as on the west side of the river and the eastern district is of such a swampy nature that the roads there are not passable except in a very few places. At any rate ditches east of that river have been constructed only along the east and west road allowances although all the north and south road allowances have been cleared of timber and scrub.

The people generally are not all satisfied with the manner in which this ditching has been executed. They feel that the cost has been excessive and that the work has not been efficiently done. In a great many cases the water must flow up grade in order to reach the outlet, viz.: Brokenhead river. One of these instances, I might be permitted to mention, is along the north boundary of sections 35 and 36, in township 13, range 7. Then again in a great many cases the material has been thrown up to form a roadbed without leaving any berm. As a result the material easily slides back into the ditch and makes travelling with vehicles dangerous. While the ground is frozen one might as well try to ride longitudinally along a large water soaked sawlog for the experience of sliding and sluing would be about the same, and unless these defects are remedied many actions will arise against the municipality for damages.

I would not have mentioned this feature of the conditions in Brokenhead district only that the statement of these facts assists in explaining a great difficulty I met with during the progress of my survey. In your instructions to me the third clause read: 'The petitions have already been forwarded to be circulated in the townships and to be signed by all owners or homesteaders.' Well, when I arrived there I found that not a single name had been attached to these petitions; that even the councillor representing the constituency in which the work was to be done would not sign or circulate it. He was the councillor who introduced the resolution into the Brokenhead council requesting the government to have the corners re-marked. Then when I arrived I found/the people who had signed the petition asking to have the drainage plan carried out, so enraged that they refused to sign another petition of any description. Then a few of these who were opposed to the survey on other grounds, industriously circulated the report that the people had been deceived by being told that they would not have to pay anything for the drainage and that they would be deceived the same way in this matter and would eventually have to pay for this survey. I mention this as a sample of the opposition with which I had to contend. They also said I was going to upset the old corners and shift the roads and thereby cause them to lose their improvements. But when I saw how groundless all this opposition was it made me all the more determined to set matters right, especially when I saw that a great many people seriously wanted to have their corners made according to the manner of instructions. It occupied a great deal of time and required a great deal of patience to induce many of the people to sign the petitions. Another class whom I could not approach at all were those who owned large farms, who knew they had larger farms than their neighbours and were afraid they would possibly be deprived of a portion of their holdings.

I think I have gone into this feature of my report sufficiently deep to give you an idea of the difficulties I had to contend with. Also on account of very few of the people being able to speak English, my progress was rendered all the more difficult. Then again the people said they had been taken advantage of in signing papers for other propositions—so that taking everything into consideration when a man comes around with a paper asking them to sign it they generally refuse to have anything to do with it. One man after a rather heated argument said 'Well, I will sign this, but if I am deceived through it, I will never sign another paper even for the preacher.' But all this opposition did not deter me in the least from plodding away, and now I fancy that if a surveyor were to return there to complete the work I was instructed to do that every man of them would sign without having to be asked. In fact, a little previous to my departure from that district I heard that such was the case.

I found that the original lines, more especially in township 14, range 8, had been surveyed in an exceptionally irregular manner. And when such is the case and roads are constructed and fences erected and the people do not gather the necessary evidence, I found it impossible in some cases to establish the corners. There is very serious confusion as to where the original corners were, especially at the northeast corners of sections 12, 24, 25 and 36 in township 14, range 7; also at the northeast corner of section 19, township 14, range 8. There are other minor cases of quarter section corners that were not established, because the interested parties would not sign the petition, but they will ultimately be settled in all probability. In the case of sections 12, 24 and 25 and section 19, the location of the exact site of the original corner is a question of evidence. The interested settlers did not show any desire to gather the necessary evidence to locate those corners, the people, who could establish the corner under oath, having moved away. I did not observe any provision in your instructions authorizing me to pay witness and transportation fees of these people to give such evidence. However, the people interested told me that evidence to establish the corners could be procured, so I followed your instructions and left these corners for them to settle amongst themselves. Then again, at the northeast corner of section 36, township 14, range 7, the original corner was lost, but the settlers all signed the agreement to abide by my corner. But after I had planted a hub at the true corner (and where many old settlers said the old post stood) some of those who had signed the petition objected. I may add that the original lines here are very seriously in error. Some of the settlers who had signed the petition consulted Winnipeg lawyers as to the legality of my position for this corner. I therefore considered it preferable not to take advantage of their having signed the petition being ignorant at the time as to where I would locate the corner, and I decided not to establish the corner. Months afterwards when I was too far away to return and establish the corner where I planted the hub, those who had objected in the first instance, requested me to return, as they were now satisfied, but it was impossible for me to return and do so.

Permit me to frankly inform you that when I first began the survey between ranges 7 and 8 across township 14 that I was much discouraged as to whether I could make a success of it, for the following reasons. Two years ago they had engineers surveying the ditches that I have already described; these ditches were to run along the road allowances north and south, and east and west, but they do not appear to have adopted any systematic plans of laying out the ditches, along this town line especially. The west side of the ditch in a great many instances coincided with the survey line for the west boundaries of the road allowance, and one was not sure that, when the engineers found the original post, they took pains to replace it where they found it. (I do not mean deliberately.) Neither was I satisfied that the workmen during the construction of the ditches did not unwittingly disturb the post. Perhaps my fears were groundless, and I do not even suggest that anyone wilfully moved a post, but here were all these factors that contributed in no small degree to my uneasiness. Every corner I did establish is perfectly satisfactory to all parties, and I renewed nearly all excepting the ones I have already mentioned, but where there was the slightest possibility of a future misunderstanding I left them, as you have instructed, to be settled through the courts. I did not in any case ride rough shod over the objections of any man so that I trust that if I have erred, that I have erred on the safe side by not doing anything that would compromise your department in the event of legal complications. Excepting with the cases I have mentioned I have had very little difficulty with the balance of the survey barring the signatures to the petitions, all of which I am herewith submitting to you.

Between August 18 and September 7, I resurveyed township 10, range 7, east of the principal meridian. Petitions had already been circulated in the township for signature, and all signed them excepting one settler, who for some reason would not consent to add his name when it was being circulated. However, after I had completed the survey, he was so well satisfied that he volunteered to sign, but as I did not anticipate any trouble, I did not deem it necessary to have his name added to the list which had already been forwarded to you.

The new Grand Trunk Pacific railway passes through this township and runs nearly parallel to the north boundary. They are making an exceptionally serviceable and permanent roadbed. I am told that the grades are easy and that there is only one curve between Winnipeg and where it crosses the main line of the Canadian Pacific railway in the neighbourhood of Rennie station. The curve I have mentioned is caused by a desire to cross the Dugald dump on the third correction line as abruptly as possible in order not to unnecessarily interfere with traffic along the highway. Owing to the fact that the railway was so parallel to the highway when they were crossing, they would necessarily follow it so far that the public became alarmed, and the council of the municipality requested this curve. The soil in this township is of a limestone gravelly nature, but still the few real famers who are in the township produce a surprisingly large quantity of grain.

Please observe that I have not in my notes discriminated in detail between the scrub, bush and cultivated lands. My reason for this departure is that the people were clearing the land so rapidly that where it is bush, scrub and prairie to-day it is cultivated and growing crops to-morrow. In conclusion I desire to take this opportunity to thank all the members of my survey party for their loyalty and support to me during the past season; as is generally the case with me I did not have a particle of trouble.

I have the honour to be, sir,

Your obedient servant,

C. F. AYLSWORTH, Jr., D.L.S.

APPENDIX No. 14.

REPORT OF DAVID BEATTY, D.L.S.

RETRACEMENT SURVEYS IN SASKATCHEWAN.

Parry Sound, March 28, 1907.

E. Deville, Esq., LL.D.,
Surveyor General,
Ottawa.

Sir,—I have the honour to submit the following report on my survey operations for the season of 1906, under your instructions bearing date April 20, 1906.

I left Parry Sound on May 19, for Battleford, where I had stored my camp outfit in the fall of 1905. I stayed a day in Winnipeg to buy tents, &c., as some of my old outfit was not in good condition. I went from Winnipeg to Battleford via the Canadian Northern railway. After reaching Battleford I was delayed four days hunting for horses which would be suitable for the work and at reasonable prices. On the fourth day I bought four horses and brought in two of my own which I had wintered at a ranch south of Battleford, and started four men with the outfit across country to Prince Albert. I afterwards bought two horses at Thompson's ranch in September. I went by train to Prince Albert, where I hired other men to make up my party. My outfit arrived at Prince Albert on June 4, and after resting my horses for a day I moved up to Sturgeon lake on the 6th, and commenced work by first running the boundary line between ranges 27 and 28, township 51, west of the second meridian. I destroyed the old monuments that had been built one chain east of the Indian reserve line. I then made a survey of that part of Sand lake which is in township 51, range 27 and resurveyed such portion of said township as I thought necessary. No settlers have come into the township since 1903, although a considerable portion of it will make fairly good farming land when cleared of the poplar timber. I found the country very difficult to survey, on account of high water in the numerous swamps and sloughs, and after receiving your permission to go into work north of Radisson and return to the Prince Albert work in the fall, I moved my outfit into township 45, range 9, west of the third meridian, arriving there July 9. I made a resurvey of about two-thirds of the lines in the township and continued my resurvey work through townships 45, 44, 43, 42, 41, range 10 and townships 44, 43, 42 and 41, range 11. In some of the townships I resurveyed all the lines. When I had finished the resurvey of township 42, range 10, I moved over to Redberry lake on September 9, and surveyed four islands, as directed, before going into township 42, range 11. After completing the resurvey of township 41, range 10 on October 10, I moved my outfit into township 38, range 13, and made a resurvey of the block composed of sections 28 and 33. From there I moved north again to township 49, range 1, west of the third meridian, going by way of Aldina, and made a survey on October 26 of that part of a lake which extends from Mistawasis Indian reserve into sections 30 and 31, township 47, range 6. I reached township 49, range 1, and commenced a resurvey of the same and continued the survey through township 50, range 1, west of the third meridian, and townships 50, ranges 28, 27 and 26, west of the second meridian. I resurveyed such lines only as I thought were necessary. I came into Prince Albert on December 12, settled with my party, stored my outfit and took my horses to their winter quarters and arrived home on December 19.

I have the honour to be, sir,
Your obedient servant,

DAVID BEATTY, *D.L.S.*

APPENDIX No. 15.

REPORT OF P. R. A. BELANGER, D.L.S.

MISCELLANEOUS SURVEYS IN THE PROVINCES OF MANITOBA, SASKATCHEWAN AND ALBERTA.

OTTAWA, ONT., March 19, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I have the honour to submit the following report on my different survey operations during last year in the provinces of Alberta, Saskatchewan and Manitoba.

In compliance with your instructions dated January 23, 1906, notifying me that I had been appointed chief commissioner for the investigation of halfbreed land claims at Lac la Biche, in company with Reverend Father H. Grandin and Mr. Wilfrid Gariepy, barrister of Edmonton, I left for Edmonton on February 26, and after meeting the other two commissioners and having made all the necessary arrangements for transport and board, we left Edmonton together on March 7 for Lac la Biche, and reached that place on the 11th.

The next day the commission began its work, and held sittings for a whole week, hearing and investigating all claims that were made and which cover mostly all the lots in the settlement.

No conflicting claims were presented, and I am glad to say that all claimants appeared to be satisfied with our decision, and proved their satisfaction by an address they presented us, expressing their gratitude for our dealings in the matter.

A full report on all the claims investigated was forwarded on March 27 to the secretary of the department, giving our ruling in each case, and recommending the action which in our judgment should be taken to give satisfaction to the claimants. Not having seen the settlement since I surveyed it in 1889, I expected to find great improvements, but I regret to say that I was much disappointed; the farming which was carried on in those days to a certain extent has been abandoned. The land which was then cultivated is now overgrown with scrub, and the inhabitants seem to care only for fishing, trapping and freighting to make their living. The land, however, is first class, and the climate would permit of raising all kinds of cereals and vegetables, but as long as it remains in the possession of the present settlers it is bound to remain uncultivated.

On my return to Edmonton I received instructions from the secretary of the department notifying the commissioners to proceed to Lake St. Ann and make a similar investigation into claims preferred by the settlers of that place; but after conferring together on this subject, it was decided to postpone the investigation until the roads should improve. In the meantime Rev. Father Grandin agreed to notify the settlers that the commissioners would be at Lake St. Ann by the end of May to investigate their claims.

Having nothing to occupy me during this interval, I returned to Ottawa and subsequently returned to Edmonton where I arrived at the beginning of May to continue the investigation. Owing to the delay occasioned by the resignation of one of the commissioners, the legal adviser, and before another one had been regularly appointed, it was the 2nd June before we could proceed to Lake St. Ann.

During this interval of delay at Edmonton, I supervised the organization of survey parties by supplying the surveyors with horses, vehicles and other articles of transport, belonging to the department and found suitable for another season's service. I also made arrangements for the disposal of the balance of all survey outfits for which there was no further use.

On the 2nd June, the commission of inquiry being once more fully organized, we proceeded to Lake St. Ann where we remained till the 8th, hearing and investigating all claims submitted to us, and on the 13th of the same month I submitted the full report of the commissioners to the secretary of the department.

During this investigation we had to deal with conflicting claims for lot 20 of the settlement, but as I had made the survey of that lot in 1889, and having in my hands the original notes of that survey, I was in a position to help the commissioners to adjust the claim and detect the rightful claimant notwithstanding the contradictory evidence given by one of the interested parties.

The remainder of June was taken up in finally disposing of the survey outfits, and investigating into the necessity of making the resurveys applied for in the vicinity of Mewassin, and on which I reported at the time.

On July 1, I left Edmonton for Yorkton where I had instructions to organize a small party and make some verification concerning the discrepancy in description of survey marks as restored in 1902 and 1903 compared with the original description.

After spending a few days at Yorkton for the purchase of my outfit and hiring men, I proceeded to File hills where I began operations. The investigation was carried over many townships in File hills and Touchwood hills, and covered a large tract of country. It was also extended to several townships in the southeastern part of Saskatchewan adjoining Manitoba along the Arcola branch of the Canadian Pacific railway.

Annotated sketches were sent to you during the season showing the verification made for all corners called for by your memorandum and also the rectification applied when necessary. This work occupied me till the middle of September after which according to new instructions, I made the traverse of a few lakes in different townships near the western boundary of Manitoba, and also removed some witness marks which had originally been placed in the road allowances.

On the completion of this work I left Kamsack on October 11 for Touchwood hills and Prince Albert for the purpose of examining survey contracts. On the way I passed through Veregin, Buchanan and another Doukhobor village situated at about two miles west of Buchanan, and I must say here that never before on my different expeditions was I better impressed than by the sight I enjoyed in passing through these villages. All the houses lie in rows at a few feet distant from one another, and are built with great symmetry and appear very neat and clean. This socialistic manner of building villages has certainly an advantage in allowing the inhabitants to visit and assist one another in case of emergency. These Doukhobors are a very moral, quiet and industrious people and notwithstanding their occasional foolish pilgrimages they are undoubtedly desirable settlers. They have already cultivated a large area of their land and their crops rank among the best in the locality.

On October 25, having finished the examination of the part of the survey contract No. 11 of 1906, which was ready for inspection, I proceeded via Wadena and Melfort to Fort à la Corne, where I inspected survey contract No. 18 of 1905, after which I spent the remainder of the season examining contract No. 12 of 1906 north of Prince Albert. Separate reports on the inspection of each of these contracts have already been submitted to you, and I do not see that much can be added to them. The country covered by these three contract surveys is more or less timbered but the timber is of no commercial value; it is good only for fuel, fencing and building purposes, except, however, in Mr. Montgomery's contract north of Prince Albert where railway ties can still be found in paying quantities though thousands of them have already been cut.

A belt of open land is found in contract No. 18 along the south bank of Saskatchewan river in townships 49 and 50, ranges 15, 16 and 17, west of the second meridian. It is very suitable for mixed farming, and at the time of the inspection I was informed that all the part available for homesteading was already taken up, and settlers were coming in to take possession of their new homes.

In contract No. 12 which is due north of Prince Albert there is very little land suitable for immediate settlement. The country is mostly all timbered and broken by numerous lakes and swamps. However, some settlers have already forced their way through this forest, and appear satisfied with their lot. Here as well as through the whole of the northern part of Prince Albert and Fort a la Corne districts the odd numbered sections with the exception of the school lands, should all be reserved for homesteads in order to encourage settlers to group themselves into small colonies over the small tracts of land suitable for farming purposes, and until this is done the settlement of this country cannot progress very much.

The lumber trade which is now carried on in a large scale north of Prince Albert is offering a good market to farmers settling in that country for the sale of hay, oats and all other products and provides also employment to thousands of men all the year round.

The completion of the Canadian Northern railway to the town last summer, and the proposal of the company to put a bridge across the river and build a branch line on the north side of the river to Battleford and Edmonton, together with its intention of connecting this town with Hudson Bay, has made the place boom and the price of town lots has risen accordingly to a high figure.

The building of these railway branches should attract the attention of intending settlers to this northern district.

During the course of the season I travelled several hundred miles across the different provinces and everywhere I noticed an activity unparalleled in the annals of the past. In the Edmonton district the country is filling up rapidly ; this country is unexcelled for mixed farming, and there is still a large quantity of desirable land ready for settlement. I consider this district the ideal country for farmers from Ontario and Quebec who cannot make up their mind to settle in open country where wood cannot be found for miles around a home.

The File hills and Touchwood hills districts which have for so long been in the wilderness, are now becoming more and more settled every day. The construction of the Grand Trunk Pacific railway which was commenced last summer, brought in numerous settlers who make their new homes along the line.

At a short distance north of Touchwood Hills post office, there is a small settlement named Wishart, established several years ago on the western edge of Round plain. This is a very rich country; all the farmers are well off and carry on mixed farming with great success. Here I saw, at Mr. Michael Hall's, a pioneer of the place, the best fields of wheat that were grown in the west during last summer, but on the other hand, I was greatly disappointed to see the adjoining land, the Round plain, still mostly vacant, when thousands of bushels of fine wheat could be raised. This is due to speculators having acquired this land with scrip, and holding it at a high price. No better country could be desired for farmers who can afford to buy farms offering all advantages as to water and fuel supply in the immediate vicinity, and the prospect of fine crops.

From Round plain to Foam lake, settlers are now seen scattered all along the country where a few years ago there was hardly anybody and at Foam lake there is a very prosperous settlement of Icelanders.

The extension of the Canadian Pacific railway from Sheho towards Saskatoon and Edmonton was under construction last summer and runs at a short distance south of Foam lake, where a small town is already started at the crossing of the creek which empties into the lake; there are already two general stores under construction. The country offers great facilities for mixed farming owing to the large quantities of hay growing in the bed of the lake. This lake has been gradually drying for the past few years, and on that account I would respectfully suggest the resurvey of it and the extension of the subdivision lines therein for the benefit of the settlers who are desirous of taking up this land.

Leaving Foam lake, I passed through townships 32, ranges 9, 10 and 11, which are better adapted for stock-raising than agriculture, though some farms are seen here and there, principally in range 9, where the land is more rolling. The main line of the Canadian Northern railway runs through the southern part of township 33, range 9, where a station named Invermay is situated, around which a small village is springing up very rapidly in section 1. The inhabitants speak very highly of the prospects of the country.

From Invermay I journeyed via Theodore through a country fairly well settled and where good crops are seen increasing in quantity and quality as we reach Yorkton the pioneer town of the district.

From Yorkton, I journeyed via Saltcoats, Churchbridge and Wapella, to Wauchope, a station on the Arcola banch of the Canadian Pacific railway, enjoying the finest sight one could witness in the Northwest. The harvest was in full swing everywhere; the country resembled an immense sea of grain and I consider it an ideal paradise for those who prefer a prairie country.

On my way back I passed through Kamsack, following the road which branches off at the Roman Catholic mission on Kee-see-koose reserve towards Bearshead lake, which lake I had to traverse. This road passes through a Galician settlement situated on the western slope of Duck mountain. The country is burnt and overgrown with young poplar, but it is sufficiently open for stock raising. Several small creeks and lakelets are found along the route, where hay is plentiful. At Bearshead lake there is a small Swede settlement raising cattle and doing well, but there is plenty of room left for settlers, who may desire to go into that district.

In conclusion, I may say that all parts of the country which I visited during my trip are very desirable for settlers, according to their tastes; those who prefer prairie districts can find the same in the southern parts, and those who prefer wooded country or bluffs can find it in the northern portion. Game is abundant as in all parts of the Northwest, duck, geese, prairie fowl and deer being plentiful. No minerals were met with in the course of my travels.

On December 22, the snow being very deep, I decided to close my operations, and after making arrangements for wintering my outfit, I left for Ottawa, where I arrived in time for New Year's greetings.

I have the honour to be, sir,
Your obedient servant,
P. R. A. BELANGER, *D.L.S.*

APPENDIX No. 16.

REPORT OF LENNOX T. BRAY, D.L.S.

SURVEYS AND RESURVEYS IN SOUTHERN ALBERTA.

AMHERSTBURG, ONT., January 30, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report on the various surveys made by me during the past season in the southwestern part of the province of Alberta.

In accordance with your instructions of April 23, I left in a few days following for Virden, Man., from which place I shipped the outfit I was to use during the season, to Macleod, Alberta. Here I met my men and proceeded to township 11, range 22, west of the 4th meridian, to investigate the necessity of a retracement and restoration survey which was reported needed.

After running the lines around this township and restoring all lost corners, I then found that the difficulty was in the east boundaries of sections 6 and 7. The monuments at the northeast corner of section 6 and on the east boundary of section 7 being out of place about ten chains, making the east boundary of the northeast quarter of section 6 long, and the east boundary of the northeast quarter of section 7 short by about the same amount.

As most of the quarter-sections governed by these monuments were homesteaded, I endeavoured to have the parties get together and sign a petition that would allow me to rectify these errors, but with no effect. I was therefore unable to make the corrections and reported the matter to you on June 3.

This township is open rolling prairie the soil varying from a sandy loam to a stiff clay.

Parts of sections 17, 18, 19 and 20 are broken by cut banks. Coal crops out along some of these cut-banks on section 18. This coal is used by some of the settlers but is of an inferior quality.

This township is nearly all settled up. On the completion of my work here, I proceeded to township 1, range 30, west of the 4th meridian and continued the survey of the Dominion lands from the northeast corner of section 32 along Oil creek through this township and township 1, range 1, west of the 5th meridian to the lake on the International boundary laying out as many sections and quarter sections adjoining the creek as was possible.

Oil creek valley being only from a quarter to about a half mile wide and bounded on both sides by high steep mountains, is timbered with thick young spruce and jackpine, though open patches occur all through it.

Through section 30, township 1, range 30 and section 25, township 1, range 1 the valley widens some. The townsite of 'Oil City' is laid out on a part of each of these sections.

The Rocky Mountain Developing company are drilling for oil on section 30. They have one well completed from which they can pump a good quality of crude oil. Two other wells are being put down by them on this section.

The Pincher Creek Oil Company are drilling a well on the north half of section 25, township 1, range 1.

Spruce and pine timber measuring up to forty-eight inches in diameter was found on section 11, township 1, range 1, scattered throughout the central part of the section.

A good wagon road, though in places of a very steep grade, leads from 'Oil City' northeasterly to the prairie.

Oil prospectors who are drilling in Flathead valley are opening up a wagon road out of the valley which will pass through both of these townships and join with the one at 'Oil City.' I next continued the Dominion land surveys from the north boundary of section 7, township 2, range 30, west of the 4th meridian, westerly along Blakiston brook into township 2, range 1, west of the 5th meridian.

On section 13, township 2, range 1, west of the 5th meridian this brook forks, one branch running westerly north of Blakiston mountain and the other running westerly south of Blakiston mountain.

I laid out sections and quarter sections on the north branch as far as the northeast corner of the northwest quarter of section 20, and along the south branch as far as the northeast corner of section 8.

Both branches of Blakiston brook have narrow valleys which are bounded by high bare mountains on both sides.

Open areas occur all through the valleys separated by thick young spruce and jackpine, which also covers the mountain sides.

A block of spruce, pine and balsam timber of about five hundred acres measuring from ten to forty inches in diameter was passed through on the north boundaries of sections 20, 21 and 22. Another block of large timber was observed on the southern part of section 8. A pack trail follows each fork of Blakiston brook through the township. I then retraced and continued the survey of the 5th meridian from the northeast corner of section 24, township 4, range 1, to the northeast corner of township 3, range 1, and completed subdividing the remaining portion of township 4, range 30, west of the 4th meridian. This township is rolling land covered with thick willow and young poplar bluffs, with intervening patches of prairie which are about equal in area. It is well watered by springs and brooks running down from the mountains. The soil is a deep black loam, covered with a luxuriant growth of grass.

This township is well adapted for ranching, though considerable land has been broken in it and grain growing started.

Eight squatters' declarations were taken and there appear to be applicants for the remaining quarter sections.

My next work was in township 5, range 2, west of the 5th meridian, where I subdivided the northern two-thirds of the township. This township lies well up in the mountains and is rough and broken by high hills, which are covered with poplar, jack-pine and young spruce, more so on their northern slopes.

There are a number of open flats in the creek valleys, which are nearly all squatted on.

The soil of this township is a thin depth of loam underlaid in most cases by a gravel subsoil.

This township is well watered and adapted for ranching.

A seam of what appears to be good coal, crops out of the cut banks on section 25.

In this township fourteen squatters' declarations were taken.

In townships 6 and 7, range 3, west of the 5th meridian I completed the west outlines and subdivided sections 19, 30, 31 and 32 in township 6, and sections 5, 6, 7 and 8 in township 7. These sections all lie well up in the mountains and are very rough and broken. As a whole they are not at all suitable for any settlement. Though portions of these sections could be used for grazing, they are mostly covered with young pine and spruce.

Coal has been mined on the northeast quarter of section 31; at present, however, the mine is not being operated.

In township 9, range 3, west of the 5th meridian, I laid out sections 1, 2, 11 and 12. Most of the east halves of sections 1 and 12 and the southwest quarter of section 1 lie in a valley which is partly covered with scrub. The soil in this valley is good.

The south half and central northern part of section 2, and central part of section 11, are in a rolling valley which is covered alternately with patches of open prairie and willow and poplar scrub. The remaining parts of these sections are broken by high bare hills.

In township 8, range 3, I completed the survey of the east outline and the subdivision of the two eastern tiers of sections and the east boundaries of sections 4, 9 and 16. The two eastern tiers of sections lie mostly in a wide undulating valley and are covered alternately with patches of prairie and willow and poplar scrub.

These sections are well watered and are suitable for ranching.

Part of the Livingstone range of mountains covers sections 4, 9 and 16 and spurs run out from them a distance of a half mile or more, making the west halves of sections 3, 10 and 15 very rough and broken. The east halves of these sections are suitable for grazing.

Prospectors report having found a good quality of magnetic iron ore on sections 21 and 22.

West of the Livingstone range of mountains I continued the west outline southerly a distance of one mile to the northeast corner of section 12, township 8, range 4. Here owing to the inaccessibility of Goat mountain I ran an offset line southerly through the centres of sections 6 and 7. As the eastern boundaries of section 5, 8 and 17 run nearly along the summit of the Livingstone range of mountains, I was compelled to run an offset line northerly through the centres of sections 5, 8 and 17. These sections are very rough and broken by deep gulches and ravines.

The soil is gravelly and covered with young spruce and poplar scrub in patches.

Coal seems to be plentiful on these sections and is being mined on section 17.

Four squatters' declarations were taken in township 8 and one in township 9.

In township 7, range 4, west of the 5th meridian, I ran out the north boundaries of section 26 and the south half of section 35 and the east boundary of the west half of section 35, and several other lines in the northeast quarter of section 35, south of the Crow's Nest branch of the Canadian Pacific railway, in connection with the claims of Messrs. Lyon, Pelletier and McKenzie. I then went to township 8, range 6, west of the 5th meridian, and ran the east boundary of section 2. Here after the continued snow storms which rendered work on the mountain sides dangerous and impossible I was compelled to give up the intention of subdividing any further in this locality, and I moved to township 3, range 30, west of the 4th meridian and laid out sections 13, 24, 25 and 36, which are rolling land covered alternately with patches of prairie and willow and poplar scrub, well watered, of excellent soil and suitable for ranching.

Closing up field operations on the completion of this work, I wintered my horses and stored my outfit at Twin Butte and arrived home on December 4th.

I have the honour to be, Sir,
Your obedient servant,
LENNOX T. BRAY, *D.L.S.*

APPENDIX No. 17.

REPORT OF P. A. CARSON, D.L.S.

TRIANGULATION SURVEYS IN THE RAILWAY BELT OF BRITISH COLUMBIA.

OTTAWA, January 4, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General, Ottawa.

SIR,—I have the honour to submit to you the following report of my field operations on the triangulation in British Columbia in connection with the Trignometrical Section of the Topographical Survey of Canada, for the season of 1906, with an accompanying map.

I will quote, Sir, from your letter dated the 4th day of July, 1906, 'A surveyor should devote the greatest care to the preparation of his annual report, that being the only thing which parliament and the public have before them to form an opinion of the surveyor's efficiency.' It would seem, therefore, that the object of a surveyor's annual report is not so much to give to the department an exhaustive technical treatise on the surveyor's field operations as to present to the public at large a clear account of the work performed, and to impart such knowledge and information as the surveyor has gleaned while in the field.

How often during the past season was I asked by tourist, merchant, farmer, prospector, by every one I met that perpetual question 'What is your survey for?' To the average person the need of ordinary surveys for the subdivision of agricultural lands, or defining mineral claims, is at once apparent. But a triangulation survey of the mountains, well, to almost all, the necessity and object of such a survey are incomprehensible.

I would say, therefore, by way of explanation, that the object of this triangulation survey is a purely practical one, viz.: of providing by a system of triangulation a number of permanent reference marks available for the extension, over adjacent areas, of surveys of all kinds—the subdivision of agricultural lands, defining the limits and boundaries of the railway belt, mineral claims, timber limits, &c.,—which are so necessary to the development and administration of all new countries. On account of the mountainous nature of that vast tract of country lying in the embrace of the Rocky and Selkirk mountains, the surveys of British Columbia are necessarily of an isolated nature, in contrast with the gigantic system of surveys so admirably developed and extended in the comparatively level provinces of western Canada. The huge framework of the system could not be extended through the mountains, where it was impossible to run base lines. Consequently, to perform required surveys in isolated valleys it was often necessary to run slender and unreliable traverses over many weary and expensive miles. Such a method was of course objectionable, and the difficulty was solved by a triangulation survey which establishes convenient permanent reference points for commencing all kinds of new surveys, and besides forms a bond connecting the main system of Dominion surveys with its outlying parts, making the whole depend upon the same astronomic and geodetic data, and securing a uniformity and consistency for the entire system not otherwise obtainable.

The method of performing such a triangulation survey is as follows:—With the assistance of all existing maps and other information of the country to be embraced by the survey, a system of triangles is projected. The shape of the triangles is dependent only on the rule that no angle of a triangle should be greater than 120° or less than 30°; the length of the sides of the triangles varies according to the nature of the country, the precision required, and the objects to be gained. In this survey the sides of the triangles are from fifteen to twenty miles in length. A reconnaissance party visits the projected stations, and decides upon their suitability, or chooses other nearby stations in their stead. In this the surveyor in charge of the reconnaissance is guided by many circumstances and conditions, such as: the existence of trails or other feasible routes by which the stations may be reached, the accessibility of the summits, the permanence and suitability of the peaks, (an ice-capped peak will not answer) the prominence of the neighbouring peaks and ranges, the intervisibility of the different stations, and so on; and upon his success in fixing these stations largely depends the ultimate success of the triangulation.

When the stations have been fixed and signals erected horizontal angles are carefully observed at each station. A base line is also located and accurately measured; then by gradually increasing triangles it is projected and extended to the main system. At certain stations astronomical observations for azimuth are taken, and the latitude and longitude also determined. By means of these data, viz.: the linear measurements of the base line, the angular measurements of the triangles carefully weighed and adjusted, and the determination of azimuth, latitude and longitude, there are then calculated the relative positions of all the triangulation stations, and other secondary reference points.

From observed and corrected vertical angles at the different stations may be determined the altitudes above sea-level of all stations, mountain peaks, and other reference points, using certain known altitudes such as the rail-levels of the Canadian Pacific railway as media of reference. Altitudes so calculated are more accurate than those obtained from unreliable and limited aneroid readings.

Each triangulation station on the summit or peak of a mountain is marked in a permanent manner. The permanent mark adopted for this survey consists of a brass bolt six inches long and three-quarters of an inch in diameter, with a flat square head one and one-half inches square and one-half inch thick. This bolt is set in a hole drilled in the rock and firmly fixed by cement. The head of the bolt is stamped with the number of the station in Roman numerals followed by the Greek letter Δ, or triangle; the apex of the triangle faces the north at the centre of the head of the bolt, and is the geodetic point. Besides its number, the station is generally given a name, such as the local name of the peak or range on which the station is situated.

As reference points for accurately determining the position of the permanent mark at any future time, are placed four separate iron bolts, set in holes drilled in the rock and fixed with cement. The bolts are each six feet distant from the geodetic point, and bear respectively north, south, east and west from it. This method of placing reference marks was followed as closely as circumstances would permit, and a detailed description of each station was taken and recorded.

Signals for observing upon from other stations were erected as follows: with the geodetic point exactly at the centre of its base a conical stone cairn was built, measuring from six to eight feet in diameter at the base, two feet in diameter at the top, and from six to ten feet high. Surmounting the cairn was placed a truncated cone of tin, two feet in diameter at the base, one foot at the top and two feet high. The top of the signal in each case is vertically above the geodetic point. The individual measurements of each signal were taken and recorded.

The triangulation of the Rocky mountains in the vicinity of the main line of the Canadian Pacific railway and its extension westward within the railway belt, British Columbia, was commenced by Mr. W. S. Drewry, D.L.S., who began operations in the spring of 1889, and carried on the work for four successive seasons. During this time signals were set and angles observed at eighteen stations of a primary system of simple triangles, extending from the fifth initial meridian westward to Mt. King, in township 27, range 19, west of the fifth meridian. The tract embraced by this network is some one hundred and ten miles in length and has an average breadth of twenty miles. For this triangulation a base line about one and one-half miles in length was measured near Cochrane, Alberta, and extended to the main triangulation. Mr. Drewry also established signals westward into the Selkirk range, but here the simple system of triangulation was enlarged, and a double chain of triangles carried across. Eight signals in all were placed, crossing the summit of the Selkirks and reaching as far westward as Twin Butte, ten miles east of Revelstoke. No angles, however, were observed west of Mt. King, and at none of the stations were permanent marks placed.

In the spring of 1893 Mr. Drewry began work on the Alaskan boundary for the British Columbian government, and about the same time a decreasing demand for lands within the railway belt, as well as in the whole of western Canada, resulted in an almost stagnant condition of Dominion surveys for several years, and of course a corresponding decrease in the government survey appropriation. The triangulation survey of the Rocky mountains was consequently discontinued, and remained in abeyance until the renewed activities of the past few years in mining and lumbering operations, and an influx of settlers in the many fertile agricultural and fruit growing valleys of British Columbia showed the necessity of recommencing the triangulation.

My instructions, dated June 2, 1906, read: 'You are to take up the work where it was left by Mr. Drewry, in 1892, as shown on the accompanying diagram, and to extend it westward. The main object of your work during the present season will be to establish permanent marks at the stations which are to be occupied, to erect signals for observing angles next season, and to select a place for measuring a base line. The latter should not be less than five miles.' I left Ottawa on June 5 for Calgary, where I outfitted for the field.

STATION XIV. (STORM MOUNT).

Storm mountain, on whose summit station xiv. is situated, was the first station visited, being on the western limit of the completed portion of the triangulation. It is a high mountain (alt. 10,300 feet) at the summit of the Rockies, on the boundary between the provinces of Alberta and British Columbia. The mountain lies in the southerly portion of township 26, range 15, west of the 5th meridian, and is visible from Castle Mountain railway station, being about six miles distant therefrom in a southwesterly direction. To reach Storm mountain we camped at Castle Mountain railway station, sixteen miles west of Banff, on the left bank of Bow river. There is a good camping ground with excellent pasturage for horses on the small flat between the railway and Castle mountain. By following the old tote road westerly up Bow river for nearly two miles, we discovered an easy ford over the river, which at this date, June 19, was still very low, owing to recent cool weather. The Vermilion trail was connected with at the ford, being about half a mile west of the mouth of

Vermilion creek. The trail keeps to high ground on the west side of the creek and was in fairly good condition. There are several small lakes along Vermilion creek in one of which we made some fine catches of large Dolly Varden trout. Some good timber still exists along the trail although a great deal has been cut for railway ties. The trail follows the south fork of Vermilion creek to Vermilion pass, a distance of about eight miles from the railway. There are many westerners who still maintain that Vermilion pass offers a better, though longer route for a railway (via Castle mountain, Vermilion pass, Vermilion, Kootenay and Beaverfoot rivers) than the present line of the Canadian Pacific railway over Big Hill or Kicking Horse pass. The altitude of Castle mountain station is 4,660 feet, and that of the summit of Vermilion pass about 5,300 feet, or a difference in elevation of six hundred and forty feet in over seven miles. The grade on the western slope would be even less. The pass is fairly wide with no danger of rock or snowslides.

About half a mile south of the pass, the trail crosses a small stream forming the headwaters of Vermilion river, flowing southerly. Here we pitched camp with Storm mountain lying to the east. The ascent of Storm mountain was made up its south slope. We descended along Vermilion river by trail for one and a half miles to the mouth of a small mountain stream flowing from the south base of Storm mountain. We ascended the small valley of this creek, guided by an old blazed trail, till we reached timber line at the head of the stream. Then attacking the steep snow-covered south slope of the mountain we attained the broad summit of Storm mountain after a climb of five and a half hours. I will not attempt to describe the magnificent panorama which may be seen from this mountain, the ever changing lights and shadows rising and falling on the frowning peaks of rock and the cold bare fields of eternal snow, extending in every direction to the blue horizon. The summit of Storm mountain was covered with three feet of snow, and on the eastern ledge of the peak a huge snow cornice ten feet high hung over the precipice. Drewry's cairn, a silent monument to the sometime presence of man, was in good condition after its fifteen years of solitary vigil. The cairn was covered with snow and the rocks were frost bound, but after considerable prying we managed to reach the bottom of the monument. In a hole drilled in the rock at the true centre of the base of the old cairn was placed a brass bolt (for description see above) fixed in cement. The head of the bolt was stamped with the number of the station in Roman numerals, followed by a triangle with its apex at the centre of the head of the marker. The apex of the triangle is the geodetic point. As reference marks were set four separate iron spikes in the rock, and fixed with cement. Each reference mark is six feet from the geodetic point, and they bear respectively north, south, east and west from it.

Over the permanent mark the conical stone cairn was rebuilt in the same position as before. The cairn measures eight feet in diameter at the base, two feet at the top, and is eight feet high. Surmounting the cairn a truncated cone of tin was placed. It was filled with stones and securely wired to the cairn. The top of the tin signal is ten feet vertically above the geodetic point.

The day of the ascent, June 23, was a clear summer day, and during our five hours stay on the summit our heads were hot and perspiring with the heat of the sun, while our feet were numb with cold. The thermometer registered 72° Fahr. on the summit at 2.30 p.m. The descent to camp was made in two hours and forty-five minutes by a series of rapid glissades, and hurried scrambles over scree and shale. The day after our climb we were attacked with snow blindness, having neglected to take snow glasses with us up the mountain, and the bright and sparkling sun wrought havoc with our eyes. Our faces too were frightfully sunburnt.

There is very little grass for horses in the vicinity of Vermilion pass, although our horses managed to find some pickings along the trail. Game is somewhat scarce, too, in this district, although we saw traces of bear, deer and marten. The trout fishing is excellent, rainbow or cut-throat trout (Salmo mykiss) and Dolly Varden trout

(Salvelinus malma) being plentiful in the small lakes and streams, although the fish are such gluttons that to a true angler their capture seems like slaughter.

STATION XVIII.

From Castle mountain the horses were sent to Field, British Columbia, via the old Canadian Pacific Railway tote road over the summit of Kicking Horse pass. The road is in very bad shape, but the trip was made without difficulty. The rest of the outfit was shipped by rail.

To locate station xviii, Mr. Drewry travelled up Amiskwi river which flows into the Kicking Horse just below Emerald river, and in making the ascent of the mountain whereon he set the signal, he had, according to his report, 'a hard, rather dangerous climb.' I learned at Field that the trail up the Amiskwi had not been used for some time, and that station xviii (under which name, by the way, the mountain is locally known) could be much more easily reached via the Yoho valley. Following this advice, we travelled to Emerald lake by an excellent wagon road, a distance of seven miles. Then we followed a well cut trail along the north side of that beautiful lake leading up and over the Yoho pass to Yoho lake (or Summit lake) where the Canadian Alpine Club held its first annual camp this summer. We then followed the upper trail northerly up the Yoho, the trail being cut along the steep sides of Mt. Vice-President and Michael peak almost at timber line. From the high elevation of this trail may be seen some of the grandest scenery in the Rockies, Takakkaw falls, Daly glacier, Mt. Daly, Mt. Balfour and the beautiful Yoho valley. Skirting lake Duchesnay the trail strikes a tributary of Yoho river, and a branch trail turns to the left, and ascends Little Yoho river, passing the broad form of Whaleback mountain, the Habel glacier—with the Isolated peak rising from the ice and snow—and reaches almost to Kiwetinok pass. We pitched camp at an altitude of six thousand feet, beside the Little Yoho, a small mountain brook some fifteen feet wide, with station xviii bearing northwest about two miles. There is a little grass in the valley of the Little Yoho, but in making this trip it is wise to camp at Emerald lake as there is no horse pasturage at Yoho lake or along the upper trail.

The ascent to station xviii was an easy one with very little green timber or brush to retard progress, on account of the high elevation of our camp. Most of the trip was a steady ascent up huge snow-fields, and the summit was reached in three and one-half hours. The whole mountain was covered with deep snow, and a cornice rose on the easterly ledge of the peak to a height of twelve feet. A strong and bitterly cold wind blew all day and during our enforced stay on the summit we suffered horribly from cold, although the thermometer really registered only 20° below freezing point. The wind so shook the transit, too, that good instrumental work was impossible.

The view from station xviii is a grand one, especially over the enormous fields of ice and snow which extend far away to the north and east, the Wapta glacier and névé, the Habel glacier, and the Waputik snow field, and forever guarding the white landscape are the cold stern gendarmes, Mummery, Habel, Collie, Baker, Gordon and Balfour. To the south are the clustered peaks of Kerr, Marpole, President, Vice-President and Michael. In the southwest stretches the thin red line of the Van Horne range; and to the west, the dark green valleys and passes near the Blaeberry stretching northerly to Howse pass.

On the summit of the mountain we found Drewry's cairn in good condition, and at the centre of its base we set the brass permanent mark in a hole drilled in the rock, fixing it firmly with cement. The head of the brassmarker was stamped with the number of the station in Roman numerals, followed by a triangle with its apex at the centre of the square head of the bolt. The apex of the triangle is the geodetic point. Two reference points were placed, being iron bolts, each set in holes drilled in the rock, and fixed with cement. One reference bolt is due south of the geodetic point and is seven feet from it. The other reference bolt is due west of the geodetic point, and is six feet six inches from it. No other reference marks were placed owing to the deep snow on the north and east sides.

Over the permanent mark the conical stone cairn was rebuilt in exactly the same position as before. Its dimensions are: seven feet in diameter at the base, two feet at the top and seven feet high. Surmounting the cairn a tin signal was placed as at station xiv. The top of the signal is nine feet vertically above the geodetic point.

We returned to Field as we came, having been absent six days, during which time we had three days' rain with several inches of snow on the third day.

STATION XVII. (MT. KING.)

Station xvii is situated on the summit of Mt. King at the southerly end of Van Horne range. This range of mountains extends from Kicking Horse river near Ottertail in a northwesterly direction to the Blaeberry, and the red colour of the rock makes the range easily distinguishable from a distance. The station lies in the northwest quarter of section 29, township 27, range 19, west of the fifth meridian, and is distant about four miles in a northwest direction from Ottertail railway station.

The mountain is reached from Field by following the Ottertail wagon road down the south side of Kicking Horse river for three or three and one-half miles; then, near the railway siding of Emerald, and about three hundred yards east of a log house by the side of the wagon road, a trail turns off down into the Kicking Horse flats. This trail follows the river for about three miles when the stream may be easily forded. The trail then leads to some old logging shacks on Otterhead river. Another set of loggers' cabins is situated a mile and a half above the first group, and camp should be pitched midway between the two logging camps. There is plenty of grass for horses along the low flats near the mouth of Otterhead river. Some of the timber along this stream has been logged and run to Palliser, but there still remain good limits of spruce, fir and cedar, although nearly all the timber is under license. Moose, deer and bear are plentiful in this vicinity, and a few goat on the mountain.

Mt. King is not an easy mountain to approach as the timber at the base and on the lower slopes is full of windfall. The climb is made easier by following some of the loggers' trails which ascend for a short distance up the lower slopes. The best ascent from the east side is up the bed of a stream which flows into the Otterhead midway between the two groups of logging cabins. The best route then is to follow this draw to its basin, cross over a shoulder to the north, and descend into the basin of the largest creek (called locally Bear creek) which flows from Mt. King into the Otterhead. This basin is the objective point, but the ascent should not be assayed up Bear creek on account of the heavy growth of alder and brush lining that stream. Much arduous toil is saved by commencing the ascent at the proper point. On gaining the basin of Bear creek the remainder of the trip is up a steep arête, which makes an interesting climb. We made the ascent from our camp on the Otterhead in seven hours and a half taking things easy all the way.

We found Drewry's cairn on the summit which is about fifty feet long east and west, but only a narrow ledge of rock north and south, with a sheer drop of five hundred feet on the north side. The cairn was razed, and at the true centre of its base a brass marker was set in the solid rock and fixed with cement. The flat top of the marker was stamped with the number of that station xvii., in Roman numerals, followed by a triangle with its apex at the centre of the head of the marker. The apex of the triangle is the geodetic point. As reference marks three iron bolts were placed in holes drilled in the rock, and fixed with cement. Each bolt is six feet distant from the geodetic point, and they bear respectively south, east and west from it.

Over the permanent mark the conical stone cairn was rebuilt in the same position as before. It measures seven feet in diameter at the base, two feet at the top, and is six feet six inches high. Surmounting the cairn a tin signal was placed. The top of the signal is eight feet six inches vertically above the geodetic point.

The ascent was made on July 4, and the day was bright and warm, with little or no wind. The thermometer registered 75° Fahr. on the summit at 3 p.m. The peak was covered with a lot of snow, and a huge cornice hung over the northerly ledge. The descent was made in four hours after a very disagreeable trip down the alder-tangled bed of Bear creek.

STATION XIX. (BLAEBERRY).

We next moved to Golden, a small lumber town, lying in the Columbia valley at the mouth of Kicking Horse river and then descended the Columbia valley about eight miles by wagon road to the flag station of Moberly.

Just west of Moberly siding there is a tract of land some eight hundred acres in extent, lying between the railway and Columbia river, part of which is muskeg and part good hay land, but mostly inundated at high water during July and August, and the greater portion of September. An optomistic outsider has purchased this land, and intends to attempt some extensive dyking and draining, although the neighbouring ranchers between Golden and Moberly cast doubt upon the feasibility of the scheme; they claim that it is impossible to drain off the abnormal seepage from the mountains as most of the land is lower than the bed of the Columbia. The enterprise should be watched with great interest, for on its success depends to a large degree the redemption of the extensive bottom-lands along Columbia river.

There are several prosperous ranchers between Golden and the Blaeberry, and excellent timber on the west side of the Columbia, some of which is being logged and run down to a sawmill at Beavermouth. There is a good site for a sawmill at the mouth of Blaeberry river, and the timber up that river is unexcelled in quality, fir, cedar and spruce growing thick, straight and sound, and of a convenient size for logging and driving. Most of the timber is on the east side of the river, that on the west side for a dozen miles being mostly burnt. The Blaeberry is a grand game district, moose, caribou, deer, bear and goat being plentiful, and at no distance from the railway.

Blaeberry river is a rapid glacial stream heading at the Howse pass. It has an average width of forty feet, and a depth of three feet, and runs nearly eight miles per hour. The valley is from half a mile to a mile in width, and in some places the river runs through gravel flats, although at about nine miles from the railway it emerges from a narrow canyon which extends for six or seven miles up the river. There is very little grass for pasturage after leaving the Columbia valley until this canyon is passed.

A good pack trail follows the east side of the Blaeberry from the Columbia, commencing just east of the Blaeberry railway bridge, although about half a mile west of Moberly, and a mile and a half east of the mouth of the Blaeberry, a trail turns off the old tote road and joins the main Blaeberry trail about three miles up the river. The mountain on which Mr. Drewry placed his cairn is on the west side of the river, and by the use of field-glasses the stone monument is visible from the trail. We ascended the Blaeberry about six miles, forded the stream at some shingle flats, and followed the west side of the river for about two miles and a half, cutting trail as we went. The ascent to the Blaeberry cairn was made via the southern slope of the mountain, up a wooded ridge covered with brulé and windfall, which made the trip to the timber line very fatiguing. Above the limit of vegetation the ascent was quite easy, and the broad summit of the mountain was gained after a six hours climb.

Station xix (Blaeberry) was marked with the usual brass marker, set flush in the rock, and fixed with cement. The head of the marker was stamped with the number of the triangulation station in Roman numerals, followed by a triangle with its apex at the centre of the head. The apex of the triangle is the geodetic point. As reference marks four several iron bolts were set in the rock, and fixed with cement. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it. Over the permanent mark a conical stone cairn was built, seven feet in diameter at the base, two feet at the top, and six feet high. Surmounting the cairn the usual tin signal was placed for observing upon. The top of the signal is eight feet vertically above the geodetic point. I afterwards discovered at some of the stations subsequently visited, that the Blaeberry signal is very hard to discern, and would perhaps be better situated on a more prominent mountain lying to the northeast of the station as at present located.

The descent from the mountain was made in three hours; we saw a herd of mountain goat which allowed us to approach to within fifty yards. During our six days sojourn in the Blaeberry country we had three days' rain. During the other three days the weather was extremely hot, and mosquitoes were somewhat troublesome.

Station xx (Beaverfoot).

After returning to Golden, we journed up the Columbia valley by the Government wagon road, our objective point being a cairn on the Beaverfoot range in township 24, range 19, west of the fifth meridian. The Beaverfoot mountains lie between Columbia and Beaverfoot rivers, and extend from Kicking Horse river in a southeasterly direction. Between this range and the Dogtooth mountains on the west side of Columbia river, Columbia valley is low and flat and about two miles wide. The river is broad and slow of current, with numerous side channels, and during the greater part of the summer floods nearly all the low hay lands in the valley to a depth of three or four feet. When the water recedes in the autumn, the farmers cut a great abundance of slough hay from the wet meadows. This hay when left uncut and protected by snow affords good pasturage for horses and cattle all winter, but when cut, it dries very quickly, and even when mixed with salt does not contain much nutriment. On the uplands of the valley the soil is sandy and dry, even gravelly, and needs irrigating for which plenty of water may be obtained in the many streams flowing from the mountains. The timber is mostly small poplar and birch, which is easily cleared, although on the lower ridges of the mountains good fir is found, most of which is under license, and is at present being cut for railway ties. There are a number of good farms for seven miles above Golden, then six miles or so of poor land, when the farms recommence and extend for one hundred miles up the valley. None of the land on the west side of the valley is taken up, as there is no wagon road tapping it. The Kootenay Central railway a branch line of the Canadian Pacific railway which will connect Golden with the upper Kootenay and the Crowsnest, has ten miles of its line under construction, but from what information I could gather I fear the inhabitants of the valley will have to wait some years yet before the line is completed and trains running. A weekly stage runs from Golden to Windermere, and a large flat bottomed steamer navigates the sand bars of the river during the summer months between Golden, Spillimacheen and Windermere carrying freight, and passengers who are not in a hurry.

It seems to me that the fruit industry, especially the hardy fruits, might be developed in this part of the Columbia valley. The sandy soil is suitable for fruit growing, and the protection which Beaverfoot mountains afford from the early sun would prevent destruction from frosts. Already some of the more enterprising farmers have experimented with some of the hardy fruits, and although the trees are still young, they are healthy and vigorous and bear good showings of apples, crab apples and plums. The valley also produces an abundance of strawberries, gooseberries, red currants and black currants, besides ordinary garden produce. Wild strawberries, raspberries, blueberries and service berries also grow in profusion.

The west boundary of Yoho Park reserve runs between ranges 19 and 20, west of the fifth meridian, to the south limit of the railway belt. There is a strip of excellent farming land therefore lying within the park, which cuts the valley like a wedge. I would respectfully point out that if the western boundary of Yoho Park was here altered and made to run along the western base of the Beaverfoot range of mountains from township 25, range 20, to the south limit of the railway belt, instead of along the astronomic meridian at present forming the boundary, the objects for which the park was extended would not be affected, but rather assisted, and, moreover, a goodly strip of agricultural and fruit raising land thrown open to settlers.

Drewry's cairn on the Beaverfoot range was found by means of field glasses, and camp was pitched near the wagon road about twenty-nine miles from Golden, with the cairn bearing N. 30° E., and distant about three miles. On crossing the lower ridges of the mountain through heavy timber, the main slope was reached and an easy ascent accomplished up a rocky spur facing the Columbia. By following well beaten goat trails we soon gained the grassy meadows at timber line and attained the summit of the mountain (alt. about 8,700 feet). While on the mountain we saw nearly thirty mountain goats, some of which were very shy, while others allowed approach to within fifty feet and moved away only when we hurled stones at them.

Station xx was marked with the orthodox brass bolt set flush in the solid rock and fixed with cement. The flat head of the marker was stamped with the number of the triangulation station in Roman numerals, followed by a triangle with its apex at the centre of the head of the marker. The apex of the triangle is the geodetic point. For reference marks four several iron bolts were cemented in holes drilled in the rock. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it.

Over the permanent mark a conical stone cairn was built, six feet in diameter at the base, two feet at the top and seven feet high. Surmounting the cairn the customary tin signal was placed. The top of the signal is nine feet vertically above the geodetic point. The summit of the mountain on which the station is situated is a long narrow one extending in the southeasterly direction of the range, and consists of three conjoined peaks. The rock at the summit is composed mostly of gray syenite-gneiss, and in consequence of the gray colour of the cairn this station is not readily discerned from a distance, especially from the direction of Spillimacheen. Subsequently I clothed the cairn with a mantle of white paint.

STATION XXI. (SPILLIMACHEEN).

From our camp near the Beaverfoot triangulation station we returned to Carbonate Landing, seventeen miles from Golden. Here Columbia river was crossed to the west side by means of a row boat, the horses swimming the main channel. At this season of the year, July 21st, the river was very high, and covered the bottom lands of the valley, narrow fringes of cottonwood and willow alone breaking the broad expanse of water. Carbonate landing some years ago was the lively gateway to the Spillimacheen, McMurdo and Lardo mines, but operations in these mining districts are now suspended, the landing is deserted, the ferry has disappeared, and the old hotel on the west bank of the river habited only by porcupines and pack-rats. Gold-bearing quartz has been discovered up the Spillimacheen, but not of a high grade, also argentiferous galena and copper pyrites in sufficient quantities to merit development if good shipping facilities could be obtained.

A good pack trail leads from Carbonate landing to a low pass at the southerly end of the Dogtooth mountains, a distance of five miles. Here the trail forks, the left branch descending to the middle and south forks of Spillimacheen river, and the right branch of the trail dropping gradually for about one thousand feet to Loon lake, a distance of four and one-half miles. This branch of the trail follows the left bank of the north fork of the Spillimacheen for about thirty miles to the pass at the heads of the north fork and Grizzly creek, where it connects with Grizzly trail, and finally emerges at the railway at Bear creek station.

For about twenty-five miles from the mouth of Spillimacheen river, which empties into the Columbia some forty miles above Golden, the Spillimacheen valley is very broad with low timbered ridges and hills holding excellent timber, some of which is now being logged. Farther up the valley the several forks and smaller confluents of the river are separated by high ranges of mountains pointing down the valley like huge inverted wedges. Here the timber is of less value.

The valley of the north fork is separated from Canyon creek on the north by a range of mountains from seven thousand to eight thousand feet high. Between the north and middle forks the watershed is low for about thirty miles from the Columbia, when the mountains increase in height, rising to an altitude of eight thousand to nine thousand feet. On the first bald moutain of this range lying between the north and middle forks, triangulation station No. xxi. (Spillimacheen) is situated, the cairn lying in the southeast quarter of section 25, township 24, range 22, west of the fifth meridian. The station may be reached from either the middle fork or north fork trail. We ascended to the cairn from a point on the north fork trail about seventeen miles from Carbonate landing, and were obliged to cross the north fork by means of a small raft, for although the stream is only some thirty feet wide, and three feet deep, the rapid current rendered fording impossible without a generous soaking. The ascent to the cairn was a comparatively easy one, being made up a rock slide on the north side of the mountain, and was accomplished in less than four hours (alt. 8,500 feet).

At station xxi. the customary brass marker was set and cemented in the rock, and stamped with the number of the triangulation station in Roman numerals, followed by a triangle with its apex at the centre of the head of the bolt. The apex of the triangle is the geodetic point. For reference marks four several iron bolts were set in the rock and firmly cemented. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it. Over the permanent mark a conical stone cairn was built, measuring six feet in diameter at the base, two feet at the top, and six feet six inches high. Surmounting the cairn the usual tin signal was placed. The top of the signal is eight feet six inches vertically above the geodetic point.

STATION XXII. (NORTH FORK).

We continued up the North Fork trail, which was in bad condition with windfall, necessitating a great deal of chopping of dry logs, and progress was therefore rather slow. At about twenty-three miles from Carbonate a pack trail turns off to the left up McMurdo creek, a tributary of the north fork of the Spillimacheen, flowing from the south through a narrow gap in the mountains. Ten miles farther on, the trail and the valley bend northerly, with Bald mountain on the west, a prairie-like hill some 7,500 feet in height, dividing the north fork from Beaver river, and extending nine or ten miles to the north as far as Grizzly creek summit; while on our right hand as we advanced up the valley, lay the large mountain on which Mr. Drewry's 'North Fork' cairn was situated. Along the north base of this mountain flows Baird brook, a glacial stream fifteen feet wide, entering the north fork about five miles from Grizzly creek pass. From this brook, which is somewhat larger than the north fork, the latter stream takes its milky colour. We camped at the junction of the two streams, at an altitude of 5,800 feet.

There are a few patches of grass along the north fork which serve as pasture for packhorses, and camping grounds must depend on these. The soil is mostly sandy and covered with jackpine. Game is scarce all through the valley except for a few grouse. On Bald mountain, however, caribou are plentiful, and smaller game as well.

The ascent to the sharp peak of station xxii. is an easy one—the best route being up Board brook for about a mile and a half to a large slide on the north side of the mountain, where a gradual slope leads to the summit (alt. 9,000 feet). The orthodox brass marker was cemented in a hole drilled in the rock. The bolt was stamped with the number of the station in Roman numerals, followed by a triangle with its apex at the centre of the head. The apex of the triangle is the geodetic point. For reference marks were placed four several iron bolts cemented in in holes drilled in the rock. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it. A conical stone cairn was built over the permanent mark. It measures six feet in diameter at the base, two feet at the top, and is six feet high. Surmounting the cairn the usual tin signal was placed. The top of the signal is eight feet vertically above the geodetic point.

The view from the sharp peak on which station xxii. is situated in an exceptionally grand one, the many ranges of mountains to the north and east appearing low and scattered in contrast with the awe-inspiring black mountains and white glaciers—the monarchs of the Selkirks—which tower above the plateau-like Bald mountain in the west. The grandeur of Mount Sir Donald as seen from the many view points along the Canadian Pacific railway has been extolled by mountaineer and tourist, but to really appreciate its massive beauty one must gaze with cold dread upon its eastern form. Cold and bleak the dark mass rises almost precipitously from Beaver river, while clustered about stand Mts. Macdonald, Avalanche, Uto, Eagle, Macoun, Donkin, Bonney, Dawson, Kilpatrick, and Wheeler, in dark contrast to the dazzling blue and white of countless glaciers, and the clear outline of the trackless Deville and Illecillewaet névés.

The great precipitation of snow and rain which falls in Spillimacheen valley, and the cold wave which nightly visits that district are doubtless caused by those immense fields of snow and rivers of ice, and the giant peaks which pierce the clouds. Our work in the Spillimacheen was greatly retarded by rain and snowstorms. We lost several days at Station xxi., and were forced to make ascents to Station xxii. At the latter cairn we were twice caught in a snowstorm which rendered it dangerous as well as disagreeable on the mountain top.

On leaving our camp near Station xxii. we advanced five miles up the North Fork trail to the low grassy summit of Grizzly creek, (alt. 6,700 feet) where the waters of the north fork and the west branch of Grizzly creek head not more than twenty-five yards apart. The summit of the pass is covered with luxuriant grass affording excellent pasturage for horses, while the bright gay colours of the many species of mountain wild flowers added greatly to the beauty of the spot. The Grizzly trail had not been travelled by horses for several years, and was littered with fallen trees most of which had to be cut out, as the trail runs along the steep mountain side so that there was no getting around obstacles which barred our passage. The trail follows the left side of the west branch of Grizzly creek high up on the hillside, but gradually descends until at about nine miles from the pass the level of the main creek is reached. Here we were obliged to ford the stream as the old bridge had been washed away by the tempestuous glacial creek. The trail then follows the right bank of the stream westerly for two miles, when a branch trail turns off to the south, crosses the Grizzly, and ascends Beaver valley. The main trail here swings to the north and descends the right or east side of Beaver river for two and one-half miles where it crosses the rapid stream by a new bridge. Then descending along the left bank for half a mile it crosses the mouth of Bear creek and commences to ascend the mountain side to quickly emerge at Bear Creek railway station.

From Bear Creek there is no trail or tote road either up or down the railway, although there is not much trouble in taking horses up the track to Rogers pass, six miles away, and from there to Glacier. Northerly from Bear Creek it is impracticable to conduct horses on account of the high bridges by which the railway crosses the many turbulent mountain streams running through deep canyons.

STATION XXIII. (BEAVERMOUTH.)

The next triangulation station visited was 'Beavermouth' cairn which is reached from the railway station of that name. Beavermouth is a small lumbering hamlet lying in Columbia valley where Beaver river enters the Columbia just as the latter turns northward to the Big Bend. The valley near Beavermouth is rather narrow, the river flowing close to the base of a mountain on the north side so that the only bottom lands are on the south side of the river. These bottom lands are low and marshy and are superb breeding places for myriads of mosquitoes, which made our lives miserable during our sojourn in this vicinity in the early part of August. Never have I suffered so much from the onslaughts of these female pests, not even among the sloughs on the British Columbian coast nor in the muskegs of Alberta. And for many a day I shall vividly recollect the frantic time we spent at Beavermouth endeavouring to snatch a few mouthfuls of food under our veils, and attempting to woo Morpheus with our lungs full of smoke from smudge-fires.

At Beavermouth there is a sawmill which is in operation most of the season, with a dozen to twenty houses for the mill hands, but there is no store or hotel. Quartz creek flows into the Columbia here from the south, but the old trail up the creek has not been used for many years and is now impassable for horses, as the auriferous quartz found up the creek did not turn out to be sufficiently rich to pay. There is good timber both up and down the Columbia, up Beaver valley, and on the lower slopes of all the mountains. Game is fairly plentiful in this vicinity, there being many bear in Beaver valley and deer in the mountains.

Immediately south of Beavermouth, and on the most northerly mountain of a low range lying between Quartz creek and Beaver river lay Drewry's cairn, to reach which we had to make a long and wearisome ascent of 4,500 feet through timber, brush and berry bushes and for a distance of over four miles before reaching timber-line; and I envoked blessings on Mr. Drewry for blazing the route through the dense timber. Although the station is situated on a very low mountain, at an altitude of only 7,250 feet, it is admirably located for the purposes of triangulation, as there are no mountains obstructing the line of sight towards 'Blaeberry,' 'North Fork,' and 'Bonney' and an uninterrupted view is obtained up the valley of Mountain creek, which solved the difficulty of carrying the triangulation across the summit of the Selkirks.

Station xxiii was marked with the customary brass bolt cemented in a hole drilled in the rock. The bolt was stamped with the number of the triangulation station in Roman numerals, followed by a triangle having its apex at the centre of the head of the bolt. The apex of the triangle is the geodetic point. For reference points were placed four several iron bolts cemented in holes drilled in the rock. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it.

Surmounting the permanent mark a conical stone cairn was built, seven feet in diameter at the base, two feet at the top and eight feet high. The usual tin signal was placed over the cairn. The top of the signal is ten feet vertically above the geodetic point. The summit of the mountain is low and broad, and to make the signal easily discernible from a distance the cairn was painted white.

STATION XXV (MT. BONNEY).

From Beavermouth we journeyed by rail to Glacier, where I made enquiries from the Swiss guides employed by the Canadian Pacific Railway company as to the best route for ascending Mt. Bonney, for I had come to the conclusion that a triangulation station on that lofty mountain was almost a necessity. From Edouard Feuz the veteran Swiss mountaineer, who already has had a wide experience amongst the Selkirks I learned that the only ascents of Mount Bonney which have been accomplished were made either via Loop creek and Mount Green, or by way of the Asulkan pass and Mount Swanzy; yet he was firmly of the conviction that the best ascent of Mount Bonney was to be made from the south side and would prove a most interesting climb. As it was necessary for me to ascend Flat creek pass, which lies south of Mount Bonney, in order to make an official visit to the hitherto invisible cairn 'Incomappleux,' as well as to reach Battle Creek cairn, I decided to follow the guide's advice. Consequently we left Glacier for Flat Creek siding, a distance of nine miles by trail. From Glacier a trail leads down past the great Loop to near Cougar creek, this trail having been recently cut out by the Canadian Pacific Railway company in order to reach the wonderful caves near Cougar creek. The last few miles to Flat Creek siding had to be made along the railway track, and I might remark, by way of parenthesis, that one of the most unpleasant duties of the season's work was driving impish pack horses along the railway track. Between Donald and Revelstoke there is no trail or tote road, and to go from one intermediate point to another it is necessary either to ship by rail, or to 'count the ties.' And a day's journey with pack horses along the railway track, with incessant dodging into narrow ditches to escape destruction from unexpected trains, well, the trials of such a day were enough to tax the temper of a saint.

Flat creek, a mountain stream about fifteen feet wide, flows into Illecillewaet river from the south almost opposite Caribou creek. A good trail follows the east side of this creek in a southerly direction for five and one-half miles to the summit. The first three miles is through good heavy timber, but as the summit is neared the valley is comparatively open. Slick creek also heads at the pass and flows in a southeasterly direction for three and one-half miles into Incomappleux river. Flat creek pass has an altitude of four thousand nine hundred and fifty feet, is about a half mile wide, and covered with luxuriant grass. Mountains rise on the east and west sides about 3,300 feet above the pass, and their lower slopes are covered with heavy green timber. Berries grow along the pass and lower slopes of the mountains in great abundance, and from the middle to the end of August attain perfection. Red raspberries, wild gooseberries, black currants and blueberries are plentiful, a delicious large black species of huckleberry (*Vaccinium Myrtilloides*) being most abundant.

We found the Incomappleux cairn on the mountain to the east of the pass, and it was undoubtedly evident that the cairn could not be used for a triangulation station as neither 'Beavermouth' nor 'North Fork' cairn was visible therefrom.

As Mount Bonney has been ascended on only a very few occasions and is considered one of the worthy climbs in the Selkirks it may perhaps be interesting to describe this first ascent from the south side. Leaving our camp on Flat Creek pass we took a small silk tent, blankets ,food for three days, and a few cooking utensils besides our usual load of a transit, camera, tripod, brass marker, reference bolts, drill, drilling hammer, cement, tin signal, wire, &c., which made good packs for the three of us. On account of the high altitude of our starting point we were soon out of the dense timber and brush and in two hours and a half after leaving camp we reached timber line of the mountain lying east of the pass. From this elevation we could see the huge form of Mount Bonney lying about four miles away in a northeasterly direction. The three conjoined peaks just emerged from the immense glacier and névé which covered the whole face of the mountain, except where a long ridge or arête extended from the easterly end of the summit and sloped gently down in a southerly direction towards Incomappleux river, separating Bonney névé from Clarke glacier. This arête seemed to be the objective point for our ascent. We crossed the small snowfield which lay on the western slope of the mountain on which we stood, and dropped over the northeasterly side of the mountain, down a glacier and couloir, which led us past precipitous rock faces over tumbled masses of fallen rock across a wonderful quarry of creamy pink marble, down into a beautiful alpine meadow. Through the pale grasses of this meadow we advanced northeasterly for a mile. We met a herd of mountain goats in the meadow, but our arrival and strange appearance did not seem to disturb these phlegmatic animals for they merely stopped feeding as we approached, and watched us with a passive interest; and not until we were within a hundred feet did they decide to depart then quietly turned about and walked slowly away some of them even grazing and cropping as they went.

As we neared the main base of Mount Bonney our progress was stopped by a deep gulch through which ran a stream heading from the glacier on the south side of the mountain, and flowing in a southerly direction being part of the headwaters of the Incomappleux. It was now two o'clock in the afternoon so we decided to camp in the alpine meadow we had just crossed. We took off our packs, and pitched our tents beside a small trickling brook, and in the shelter of a group of stunted fir. Soon we had a roaring log fire ablaze and its warmth was greatly appreciated as the air grew quite chilly at this high altitude (7,000 feet) as soon as the early sun disappeared behind the western peaks.

Leaving our little camp in the meadow at six a.m. (August 22nd), we followed the edge of the deep gulch separating us from Mt. Bonney, until we gained the head of the stream at the tongue of the glacier. Crossing the stream we skirted back on the left or east side of the gulch for half a mile, when we commenced the rocky ascent of the ridge where we had decided the easiest ascent was to be found. On this mountain, as indeed in all our climbs, we failed to show the true mountaineering spirit, which, I am told, has a penchant for seeking the most difficult routes of ascent; instead, we always carefully searched for the safest and easiest route. After ascending some twelve hundred feet we reached the edge of the arête between Bonney névé and Clarke glacier. We then struck northerly along the narrow ridge of rock, and when possible walked briskly on the crisp snow of the sloping névé. After a steady pull of two hours and a half (the whole ascent from our flying camp occupying five hours) we reached the summit of Mt. Bonney (altitude 10,205 feet), and such a view! Fields of snow and rivers of ice, some of the largest névés known to man, extended to the north, the east and the south. Illecillewaet, Deville, Van Horne and Bonney névés, and the mighty glaciers below these tracts of snow. The highest peaks of the Selkirks clustered around—Duncan, Purity, Wheeler, Dawson, Fox and Sir Donald. To the north was the Hermit range, with the Swiss peaks and the Camels. Far away to the northwest stood a heterogeneous mass of snowy mountains, yet unnamed and yet unwon. Like mere plateaus in the undulating valley appeared Mts. Afton and Abbott, those worthy climbs from Glacier House. Five hundred feet below our feet over the precipitous northern ledge of the summit lay Bonney glacier, from which flowed a small creek towards and under the great loop of the railway whose snake-like form we could discern in the distance. The summit of Mt. Bonney extends for two hundred feet east and west, but it is a mere ledge of rock north and south. It is composed of three united peaks of almost equal height, the middle one, however, having the advantage by a few feet.

Station xxv. is situated on the summit of Mt. Bonney, in the Selkirk range, at an altitude of 10,205 feet. It lies in section 10, township 26, range 26, west of the fifth meridian. The station is marked by the customary brass bolt set and cemented in a hole drilled in the rock. The head of the marker is stamped with the number of the triangulation station in Roman numerals, followed by a triangle with its apex at the centre of the head of the bolt. The apex of the triangle is the geodetic point. For reference marks were placed two iron bolts set and cemented in holes drilled in the rock. The bolts are each six feet from the geodetic point, and bear respectively north and east from it. Two other reference points were also marked at this station, being crosses cut in the rock; the centre of each cross is six feet from the geodetic point, and they bear respectively south and west from it. Over the permanent mark a conical stone cairn was built, six feet in diameter at the base, two feet at the top, and six feet six inches high. Surmounting the cairn the customary tin signal was placed. The top of the signal is eight feet six inches vertically above the geodetic point.

The day of the ascent was fine and warm, with very little wind. The thermometer registered 97° Fahr. at the summit at 2 p.m. The descent to our flying camp in the Alpine meadow was made in three hours, and thence to the main camp in Flat Creek pass in four hours.

From Flat Creek pass we set out for Battle Creek to seek the cairn set by Mr. Drewry in the vicinity of that creek, although I had been unable to discover it from any station already occupied. The trail followed the west side of Slick creek, and about two and a half miles from the pass Jeopardy slide was met, which the trail crossed and descended by many switch-backs cut in the steep slide overgrown with alder, devil's club and other brush. At the slide a branch trail turned off to the right leading up to some mining claims which are being developed near the head of Bain brook. At these claims, and some on Incomappleux river, a high grade argentiferous galena ore is found, and these mines should prove to be paying propositions in the near future.

At about four and one-half miles from the pass the bed of Incomappleux river was gained, the river here flowing through gravel flats about fifty yards wide. The trail crossed the mouth of Bain brook, and followed the west shore of the Incomappleux for one and one-half miles to a narrow gorge in the river, where some old stringers showed us that a bridge had once spanned the stream. As it was impossible to cross the rushing river at this point, we retraced our steps half a mile, and forded the stream at the shingle flats. The trail ran along the east side of the river, crossing the broad slides where huge avalanches had carried away every vestige of green timber. These slides were overgrown with a rank entanglement of alder thicket, devil's club, nettles and brush, growing over five feet high, through which search for the trail was a trying task. After six miles of the most disagreeable travelling we had experienced all summer we reached Battle creek, thirteen miles from Flat Creek pass. Battle creek is a large tributary of Incomappleux river, flowing into it from the east; it rises from several large glaciers near the head of Beaver and Duncan rivers, and is a rapid stream some twenty-five feet wide, flowing mostly through rocky canyons. The bridge over Battle creek was gone, and we set our main camp on the north side of the creek near the trail. Some grass for horses may be found on the slides along a great part of the trail; and several small meadows along the Incomappleux, just below Battle creek, afford good pasturage for horses. These meadows are the haunts of herds of caribou and elk. Bears, too, are plentiful throughout the valleys of the last mentioned streams, especially in the month of August, when the many species of berries are ripe. There is some good timber along the Incomappleux, which it might be possible to drive to the Arrow lakes, in spite of the rapids and falls in the river. There is one fall of fifty feet on the Incomappleux about three-quarters of a mile above Battle creek. I saw some enormous cedar trees in the Incomappleux valley fully ten feet in diameter, but they were mostly rotten at the centre.

After making a tentative ascent of a mountain near our main camp at Battle creek, we took packs on our backs and went up the left side of the creek through very rough country. About three miles from the mouth of the stream we ascended to the timber line of a range of mountains lying south of the creek, called Battle range. From the peak of one of these mountains I searched in vain for Mr. Drewry's cairn, which he placed in this vicinity. Every mountain for miles around I swept with telescope and field-glasses, and soon came to the conclusion that the cairn no longer existed. An enormous mass of tumbled rock showed where a high peak had once stood, but now lay scattered and fallen on the neighbouring slopes. I placed a reference cairn on a high mountain to the east, but as neither station xxi nor xxii was visible therefrom, no permanent mark was set. I was unable to locate any of the peaks I had seen from 'Spillimacheen' and 'North Fork' cairns, but am of the conviction that a satisfactory location of station xxiv can be found near the heads of Beaver and Duncan rivers. On giving up the hope that anything further could be accomplished in the vicinity of Battle creek, we returned to Flat creek siding, whence the horses were sent to Albert Canyon along the railway track. From Albert Canyon, a wagon road follows the north fork of Illecillewaet river for twenty-nine miles, to the summit of the north fork and Downie creek, where the Waverley and Tangier mines are located. The wagon road was built at great expense by the provincial government to encourage the development of the mines, but after a considerable sum of money had been spent by the English syndicate which had bought the Waverley mine, and after gross mismanagement, and even misappropriation of funds, if we are to believe the tales that are told, the mine was closed without shipping any ore. The Lanark mines at Laurie, a pretty little mining town between Flat creek and Albert canyon, have a somewhat similar history. By sad experience it has been learned that Canadian mines cannot be successfully operated from Piccadilly, and the present dormant condition of British Columbia mining is the sorrowful result. I understand, however, that the Waverley, Tangier and Lanark properties are all considered good propositions, and I saw excellent specimens or argentiferous galena from these and other mines, on the north fork of the Illecillewaet, Corbin pass, Bain brook and the Incomappleux. The impetus given to British Columbia mining during the last year especially in Rossland and the lower Kootenays, leads me to believe that the next few years will see renewed activity all through the province, although it is difficult to conjecture just what effect the present boom in Cobalt will have on British Columbia. Will the much-needed capital be diverted to the wonderful silver district in northern Ontario, or rather will not confidence be awakened in all Canadian mining?

STATION XXVI (ILLECILLEWAET).

The Illecillewaet valley at Albert Canyon railway station is about half a mile wide, and there are here a couple of prosperous farms. A mineral spring with water of tepid temperature, gushes from the base of a mountain quite close to the village. The wagon road leading up the north fork of the Illecillewaet crosses the main branch of the Illecillewaet, about one and one-half miles from the railway, by a wooden bridge, then swings to the left towards the north fork, whose mouth is one-half mile below the bridge. The road then follows the east side of the north fork for about three miles, crosses the stream by another bridge, and continues up the west side of the river for five miles through some excellent stretches of spruce, hemlock, cedar and fir. In several places gumbo slides had cut away the road and we had to hack out a trail with mattocks. At about nine miles from the railway the road again crosses the river, at a brokendown log stopping house, locally known as 'Klondike,' and from here to the summit the road follows the east side of the stream. The north fork is a rapid glacial stream from twenty to fifty feet wide, with an average depth of three feet. In its lower waters small trout abound. The valley is comparatively narrow with good timber on both sides. The mountains guarding the west are stern and forbidding, rising about nine thousand feet high, and mostly laden with snow. Those on the east have a gentler appearance from the valley, except the snow-capped Corbin peak, and in many green meadows near the timber-line herds of caribou range. Bear, too, are plentiful, and cougar have been seen.

At about six miles from 'Klondike' we arrived at another log stopping place called 'The Farm.' Here we camped to spy out the mountains, and after some tentative climbs on neighbouring peaks in order to locate a satisfactory station, I decided on a mountain lying N. 30° E., from the old hotel. After an easy ascent to the summit, I placed station xxvi. (Illecillewaet) with the usual brass marker set and cemented in the rock. The marker was stamped with the number of the station in Roman numerals, followed by a triangle with its apex at the centre of the head of the bolt. The apex of the triangle is the geodetic point. For reference marks were set and cemented in the rock four several iron bolts. The bolts are each six feet from the geodetic point, and bear respectively north, south, east and west from it. Over the permanent mark was built a conical stone cairn, six feet in diameter at the base, two feet at the top and six feet high. Surmounting the cairn the usual tin signal was placed, and the cairn draped with white cotton. The top of the signal is eight feet vertically above the geodetic point.

During our stay up the valley of the north fork we were troubled with incessant rains, and fresh snow on the mountains.

STATION XXVII. (ALBERT).

Returning to Albert Canyon we moved by pack horses down the railway track a distance of ten miles to Twin Butte bridge, where by a bridge sixty-five feet high the railway crosses the small twin creeks flowing from the south into the Illecillewaet. There was no horse feed in this vicinity, so I sent the horses back to Albert Canyon in care of two men. We ascended a mountain lying in the northeasterly bend of Twin creek east, and found Drewry's cairn on a spur of the mountain along whose base the railway runs. I set a cairn and signal for station xxvii on a higher peak to the east, but did not place a permanent mark, as the final position of this station depends on the alteration of station xxiv, as well as on the yet unlocated stations westwards towards Revelstoke. While on the mountain setting this station, we were caught in a snowstorm which kept us up above for two days, during which time we suffered considerably from the wet and cold. The descent of the mountain through the fresh deep snow was extremely disagreeable and trying especially as we were encumbered with heavy packs.

From our experience on the west slope of the Selkirks I should say that the early part of the season is the only time of the year to accomplish satisfactory triangulation work in this district, for the precipitation here from the moisture-laden winds from the Pacific is enormous, especially during the month of September.

BASE LINE.

As it was now about October 1, and the season for mountain work pretty well advanced, I decided to return to the Columbia valley to attend to the important work of selecting a place for measuring a base line, which according to my instructions 'should not be less than five miles.' From what I had seen of the mountainous country between Revelstoke and the eastern slope of the Rockies, I was fully aware that it would be no easy task to find a stretch of country which would give a straight line five miles in length whose extent would be comparatively level and unbroken by wide channels or marshes. With the base line in view all season, I had carefully looked over all the country through which we passed, and had decided that the only available solution was to be found in the Columbia valley between Donald and the south limit of the railway belt, a distance of some fifty miles. I hoped to obtain a dry level stretch of five miles along the bottom lands of Columbia river, for I had been assured that all the sloughs would dry out in the fall. Dry out they did, sufficiently to allow the farmers to cut slough hay along the edges, but it was a different proposition when it came to lay out a Euclidian line five miles in length. The presence of bullrushes and marsh grasses, the muskrat domes, and flocks of wild ducks and geese were indisputable evidence that the water would remain until the frost and snow came. However the familiarity I had gained with the country, assisted by maps and previous surveys at length enabled me to locate a satisfactory line along the edges of the bottom lands of the Columbia about twenty-one miles above the town of Golden. The base line as established measures approximately 427·88 chains, chained with a steel tape; the line lies along the right shore of Columbia river near the wagon road, in townships 24, ranges 19 and 20, west of the fifth meridian. It runs mostly through small poplar and birch with occasional patches of spruce and fir. The mountains on each side of the valley are exceptionally suitable for extending the base to the main triangulation by three or four intermediate stations. Temporary marks and signals were erected on the base in preparation for linear and angular measurements next season.

STATION XXVII. (ALBERT).

The survey season for mountain work is very short, extending from the first or second week in June until the middle of October, for after the latter date the fresh snow which nightly falls on the mountains renders distant signals invisible besides making climbing disagreeable and dangerous. During the season the work of the survey is greatly retarded by rains and cloudy weather, and when much travelling is done it is rather difficult to make good use of such fine days as are suitable for climbing and observing. During the latter half of the month of June, near the summit of the Rockies, it rained seven days. In July, while we were in Columbia valley, and up the north fork of the Spillimacheen, it rained twelve days. In August at Beavermouth, Incomappleux and Flat creeks, we had beautiful weather, with only eight days rain. But in September, on the western slope of the Selkirks we had only ten fine days all month. In the Columbia valley during the month of October, we had twelve days on which it rained, eight days were more or less cloudy and unsuitable for mountain work while the remaining eleven days were fine and clear.

Dense smoke, filling the valleys and obscuring the mountain peaks also seriously retards the work of mountain surveys, for a short period every summer. While we were at Beavermouth during the first week in August the thick smoky haze which we first noticed at Bear creek grew rapidly worse, and soon filled the Columbia and Beaver valleys, obscuring the view of the mountains almost without interruption for a fortnight. The smoke came from numerous forest fires up Bush river, Columbia river above Golden and at Albert Canyon. Each year these large forest fires destroy much valuable timber and are a serious menace to the timbering industry as well as to the safety of public and private property. Whether these fires all result from uncontrollable natural phenonema or from wilful negligence on the part of campers and prospectors it is difficult to ascertain; although I am certain of this, that men who have occasion to light fires in a timbered country during the dry season, do not always take proper precautions to see that their fires are completely extinguished; and I know from experience that a small fire which seems black and dead, may still be smouldering in the dry moss and loam, and on the slightest provocation from a friendly breeze may soon develop into a dangerous and destructive forest fire. The Bush Fire Act, while a stringent law, cannot be enforced over such a large territory without the interested co-operation of every man in the province.

Of flora and fauna I shall not speak. The many genera and species of mountain wild flowers which bloom with gay colours in valley and on mountain side are a continual source of pleasure and study to all lovers of nature, to whom I would recommend that excellent compilation 'Mountain Wild Flowers of Canada' by Mrs. Julia Henshaw, a Canadian. Professor Macoun's appendix to Mr. A. O. Wheeler's 'The Selkirk Range' deals exclusively with the mammals, birds, fish, flowers and berries of the Selkirks. And to those who are interested in large game 'Camp-fires in the Canadian Rockies' by Hornady-Phillips will prove most instructive and fascinating. Every day we hear the lament that large game is becoming scarce, nay extinct, in the mountains, but I assure all pessimistic hunters that there is game aplenty yet, if they are not too lazy to go a day's journey from the noisy railway.

I have the honour to be, sir,
Your obedient servant,

P. A. CARSON, *D.L.S.*

APPENDIX No. 18.

REPORT OF R. W. CAUTLEY, D.L.S.

SURVEY OF BLOCK OUTLINES IN THE PROVINCE OF ALBERTA.

EDMONTON, ALTA., March 28, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General.
Ottawa.

SIR.—I have the honour to submit the following report of my field operations during the past winter season 1906-07 under instructions of September 27, as amended under further instructions of October 31, 1906.

I commenced outfitting on October 13 at Edmonton, but owing to the state of the local labour market and the great difficulty I experienced in securing suitable horses at a reasonable price it was November 5 before I was finally able to start. The universal prosperity of this district during the past year and the great activity in railroad construction, building, farming and lumbering have resulted in creating an unlimited and therefore, unsatisfied demand for labour and horses, which has raised the wages of one and the price of the other to an unprecedented extent, so that it is not remarkable that the men who presented themselves for survey work should have been small in number and not up to the standard of former years. On November 7 there was a great snowstorm and I was obliged to leave the wagons, with which I had started out and proceed on the sleighs, and although the sleighing was very bad for a few days it soon became good and has continued so all winter.

Proceeding north on the Athabaska Landing wagon road, I arirved at the 17th base line on November 13. From November 13 to December 18 the whole party was occupied in cutting a sleigh road from the Athabaska Landing trail at the northeast corner of township 64, range 23, to the point of commencement at the northeast corner of township 64, range 17, west of the 4th meridian, a distance of 36 miles through country covered with heavy windfallen brulé or woods. This involved a serious loss of time and was the more disappointing because the country in the immediate vicinity of the Landing trail is partly open and otherwise covered with small poplar and willow through which it is very easy to make a road, but from what I now know of the country I am convinced that it was the most practicable method of procedure.

From December 19 to March 9, 1907, I surveyed the 17th base line through ranges 17 to 27 inclusive, closing on the 5th meridian, and resurveyed 10 miles of meridional section lines in ranges 22 and 23 to connect with work already done.

Having thus completed the work covered by my instructions I started back on March 11 and arriving in Edmonton on March 16, 1907, paid off my party.

There are several scattered settlements in the vicinity of ranges 21 and 22, tributary to the important and growing town of Athabaska Landing, but there yet remains much land that is suitable for settlement and there is no doubt that a large number of settlers will come into this country during the next year or two, particularly as it is served by the best and most heavily travelled wagon road out of Edmonton and Fort Saskatchewan, namely the Athabaska Landing trail. As it is, the people already settled at and near the Landing, seem to be very anxious for further subdivisions in their district and to expect a great advance both in population and development in the near future. Here, as elsewhere, the winter has been the most severe known for years, but there was at no time more than two feet of snow where I was working, which is at least a foot less than there was in Saskatchewan valley; the lowest temperatures recorded in camp were on the 2nd and 4th days of February, when the thermometer reading fell for a few hours below—50°, reaching a minimum of—56° F.

Moose were seen by members of the party on three occasions but being so near to the Landing, and to several small bands of Indians, the country is pretty well hunted and trapped over.

I have the honour to be, sir,
Your obedient servant,
R. W. CAUTLEY, *D.L.S.*

APPENDIX No. 19.

REPORT OF WM. CHRISTIE, D.L.S.

RESURVEYS IN EASTERN MANITOBA.

CHESLEY, ONT., February 5, 1907.

E. DEVILLE, ESQ., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour, in accordance with my instructions to make the following report on my surveys in eastern Manitoba during the season of 1906.

On April 30 I received your instructions dated April 27, by which I was instructed to make a retracement and restoration survey of those portions of townships 17, range 1, township 18, range 2, townships 19, ranges 3, 4 and 5, and townships 20, ranges 3, 4, 5 and 6, all west of the principal meridian, which had not been surveyed by Mr. Bray in 1905.

My instructions provided that I should consult with Mr. Geo. A. Grover, D.L.S., who was engaged on the same kind of work in townships east of those allotted to me, and be guided by any general instructions he might give. It was also provided that my party should consist of a cook and nine labourers, and that my transportation outfit should consist of a buckboard, two wagons and six horses. I was to take the outfit used by Mr. Nash in 1905. My party was to be organized at Winnipeg.

On May 4, I started for the west and proceeded directly to Teulon to consult with Mr. Grover. I arrived in Teulon on May 7, and on the 8th I drove out to see Mr. Grover, and received from him some valuable information regarding the nature of the survey. On May 9, I returned to Winnipeg and spent until the 16th, organizing my party and getting my outfit in readiness. On the 16th, I returned to Teulon, the outfit arriving there on the 17th. On the 19th, I left Teulon with the party for the work. I had decided to begin work in township 19, range 3, west of the principal meridian, since I had only received plans of this township and of township 19, range 4.

The route taken to reach this township was to follow the colonization road, leading from Teulon to Fisher river, as far as the east boundary of section 11, township 18, range 1, west of the principal meridian. From this point a trail leads in a northwesterly direction to Shoal lake and follows around the north shore of the lake. This road was in fairly good condition at the time we passed over it, but there is every indication that during wet weather it would be in a very bad condition. On May 21 we arrived in township 19, range 3, and on the 22nd commenced the survey.

(NOTE.—Description of the townships surveyed have been taken from this report and published as part of Appendix No. 46).

In township 19, range 3, comparatively few of the monuments of the original survey could be found. Such of them as could be found showed that the original survey had been very irregular. Only the outlines of this township were surveyed by Mr. Bray in 1905.

Only the outlines of township 19, range 4 had been resurveyed by Mr. Bray in 1905. In the east half of the township, most of the monuments of the original survey had been lost, while in the west half of the township most of the original monuments were still to be found. The original survey of this township was much less irregular than that of township 19, range 3.

Owing to a mistake in forwarding my mail from Winnipeg, at the time of surveying township 19, range 5, I had not received the plan showing the work previously done in the township. I was indebted to Mr. Grover for a sketch showing the lines surveyed by Mr. Martin, which I found very helpful though not altogether reliable. I was also informed by the settlers that a survey of the marshy land along the shore of lake Manitoba, and a traverse of the shore of the lake had been made during the winter or early spring of 1906. But at many of the section and quarter section corners, on the lines reported to have been surveyed, I failed to find any monuments. I therefore surveyed several of these lines again and established monuments.

In township 20, range 5, most of the meridian section lines and the central chord line had been surveyed by Mr. Bray in 1905. On the lines surveyed by me, I found only two of the monuments of the original survey.

In township 20, range 4, Mr. Bray had resurveyed all the meridian lines, except the north half of the east boundary of the township. He also surveyed eight and one-half miles of the interior chord lines, besides the chord outlines. Most of the monuments of the original survey had been lost.

In township 20, range 3, Mr. Bray had resurveyed the township outlines, with the exception of the west boundaries of sections 19, 30 and 31, the central meridional section line and the north boundaries of sections 13, 14 and 15. In this township some large discrepancies occurred between the original and the subsequent surveys.

On November 17, I completed the survey of township 17, range 1, and on the 19th started for Teulon with the outfit. As there was then from two and one-half to three feet of snow on the ground in that vicinity, travelling with wagons was very difficult. On the 20th we arrived in Teulon, and I received your telegram dated November 14, stating that a complete survey was required in township 22, range 4, east, before closing work, and that instructions had been mailed or would be mailed to Teulon. I did not receive the instructions.

As the snow was already so deep in that vicinity, I did not consider it expedient to try to make the survey referred to then, as it would be next to impossible to find old monuments under such a depth of snow. I accordingly telegraphed you for further instructions, and in reply was instructed to close operations and discharge my party, which I proceeded to do.

I stored the outfit with Mr. W. C. McKinnell, of Teulon, into whose charge I also gave the horses to be wintered.

I have the honour to be, sir,
Your obedient servant,

WM. CHRISTIE, *D.L.S.*

APPENDIX No. 20.

REPORT OF W. J. DEANS, D.L.S.

SURVEYS AND RESURVEYS IN THE PROVINCES OF MANITOBA AND SASKATCHEWAN.

BRANDON, MAN., February 9, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I have the honour to submit the following general report of my survey operations during the season of 1906, in the provinces of Manitoba and Saskatchewan.

Having received your instructions of January 11 in reference to subdividing the marsh lands adjoining the shores of lake Manitoba I organized a small survey party at Brandon and left for Oak Point on January 20. On my arrival at Oak Point I interviewed Mr. Reykdal, who was wintering Mr. Edgar Bray's outfit. I got two horses from him, and purchased a sleigh, and on January 25 left Oak Point to commence work in township 19, range 5, west of the principal meridian. In this township I extended lines subdividing all the marsh and land right to the shore of lake Manitoba. The part of the township which I subdivided is a large marsh, separated from the lake by a sandy beach, varying in width from three to five chains. Most of the marsh is covered with water, but there are some few ridges of dry land. There are a number of creeks or channels running through the marsh to the lake; considerable hay is cut on the ridges in the marsh, although it must be a difficult matter to get horses and machinery out to do the work.

In township 19, range 6, west of the principal meridian, I retraced all the lines and extended the eastern boundary south to the lake shore. This fractional township is largely hay land and marsh, although there are a few small areas which would no doubt produce grain. The settlers are largely engaged in cattle raising and dairying.

In township 18, range 5, west of the principal meridian, I extended the lines through the marsh to the lake shore, thus subdividing the township completely. The westerly part of this township is marsh, except a narrow sandy beach along the shore of lake Manitoba. This beach varies in width from three to five chains, and in places is covered with small poplar and willow. The Oak Point Shooting Club have buildings on section 27 in this township. There are a few ridges and islands of high land throughout the marsh on which hay is cut, but most of the marsh is covered with water, and in numerous places large ponds of water exist. Wild ducks abound throughout the season, and some of the settlers make considerable money shooting them and shipping to Winnipeg. Large quantities of fish are taken from lake Manitoba by the settlers, who find a ready market for them at Oak Point. I was greatly retarded in carrying out this work by cold, stormy weather which prevailed during February.

In township 16, range 4, west of the principal meridian, I retraced some of the lines along the lake shore and ran some which were omitted in the original survey. The sketch furnished me of this township showed the south boundary extending some ten chains farther west than it does at the present time. There either was an error in the original survey or considerable of the beach has been washed away by the lake. St. Laurent, a village located in this township, is quite a thriving place, and in summer time is much patronized by the people of Winnipeg as a summer resort.

On April 23 I received your instructions in reference to retracements and restoration surveys in townships 6 and 7, ranges 28 and 29, west of the principal meridian. I immediately went to Oak Point, took over the balance of Mr. Edgar Bray's outfit, strengthened my party as instructed, and started for Portage la Prairie, in which place I arrived Wednesday, April 25. Here I engaged a car and shipped the outfit to Reston, arriving there on April 27. I intended that my first camp should have been at Reston, but afterwards thought it would be better to move to Sinclair, a point nine miles west. I accordingly moved there and started work. I found most of the horses in my outfit in very poor condition and unable to do the work satisfactorily, but after a week of good care they improved so that I was able to carry on the work and to make good progress. I found a great many of the mounds throughout these townships badly obliterated and in great need of restoration. These four townships are well settled, but I was very much surprised to find that only about ten per cent (10 per cent) of the land is under cultivation. The price of wild lands in these townships varies from ten dollars to fifteen dollars an acre. One settler told me that he paid fourteen dollars an acre for a section of land and paid for it with the proceeds of two crops of wheat. One great drawback for the settlers in these townships is the scarcity of fuel, they being entirely dependent on the railways for the supply, which is brought in from outside points. We had a great deal of rain during May and June, which interfered with the carrying on of the work considerably, but which was of inestimable value to the growing crops. I completed this work on Monday, June 25, and on the 26th started by road for township 27, range 9, west of the second meridian, being unable to get any satisfaction from the Canadian Pacific railway representatives at Sinclair as to when I could procure a car. I arrived at this township on July 4. My instructions were to rectify an error which existed in the survey of this township. I retraced all the lines in the easterly half, and found the east boundary of section 34 to be 14·43 chains short, while the east boundary of the south half of section 3 was 10·70 chains too long. The settler owning the south half of section 3 would not sign a petition to have the survey rectified, so that it was impossible for me to do anything more than retrace the lines and restore the monuments. On July 14, I moved the outfit to Stoughton, a station on the Arcola branch of the Canadian Pacific railway, and procured a car and shipped the outfit to Sinclair, from which place I moved the outfit to township 5, range 29, west of the principal meridian, and started to retrace the lines and restore the monuments in this township and also in township 5, range 28, west of the principal meridian. I completed the work in these townships on August 6, and on the 7th moved camp to township

9, range 29, west of the principal meridian, where I had instructions to retrace the lines and restore the monuments. I also retraced the lines and restored the monuments in township 8, range 29, west of the principal meridian. On August 24, I moved the camp to township 8, range 28, west of the principal meridian, and retraced the lines and restored the monuments in this township. On September 5, I moved the camp to township 7, range 27, west of the principal meridian, and retraced the lines and restored the monuments there. This latter township is nearly all under cultivation and produces large quantities of wheat of the best quality, which is marketed at Reston, a prosperous town of some three or four hundred inhabitants.

On September 13, I moved the outfit into Reston, and shipped the same by train to Gladstone. My instructions were to subdivide those portions of Big-grass marsh which had dried up in townships 15, 16, 17 and 18, ranges 10 and 11, west of the principal meridian. In order to do this work I moved the camp to section 16, township 15, range 11, west of the principal meridian. After completing as much of the work as possible from this camp, I moved to section 28, township 17, range 11, and after working here for some time I moved the camp to section 5, township 17, range 10. From this camp I completed the work. I found the monuments in townships 17 and 18, range 10, badly obliterated. I would recommend that the rest of the lines in these townships be retraced and the monuments restored.

Big-grass marsh appears to be in much the same condition now as at the time of the original survey, except the southerly and westerly parts, which are now much drier, owing to the drainage work which has been carried out in the southerly part. If the water in Big-grass river, which enters the north end of the marsh, were carried to a proper outlet, a large portion of the marsh would be drained and the lands adjoining advantageously affected. I completed the work for the season on October 25 and paid off the men. On the 27th I stored the outfit and started for Brandon, where I arrived on the 29th.

I have the honour to be, sir,
Your obedient servant,

W. J. DEANS, *D.L.S.*

APPENDIX No. 21.

REPORT OF C. C. FAIRCHILD, D.L.S.

SURVEYS IN SOUTHERN ALBERTA.

BRANTFORD, Jan. 28, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to report as follows pursuant to instructions dated April 14, 1906.

I left Brantford on May 7, and proceeded to Calgary where I gathered a party and went on to Banff where I arrived on May 12. I went into camp and began actual operations on May 17, commencing with the unfinished portion of township 26, range 11, west of the fifth meridian.

The first part of the season's work consisted of a subdivision of the coal area around Bankhead, which practically embraced Cascade mountain and the valley of Cascade river to the north and east of the mountain and a part of the range on the north and east of this valley.

We were considerably hindered by continuous cloudy weather and numerous rainy days, and I was unable to get an astronomical observation until June 20. The interim was spent in retracing and producing the old lines in township 26, range 11, and running new lines in this township and in township 26, range 12. The east boundary of section 14, township 26, range 12, passes a little to the east of the peak of Cascade mountain which is only accessible from the west side.

I spent from June 28 to July 9 moving camp to this accessible side and in attempting to carry this line over the mountain, but was unable to reach it at any point and was forced to give up, but not until after we had scaled the highest peaks in vain efforts to produce the line. The snow was four feet deep in many places and soft and sliding, rendering climbing both difficult and dangerous. On retiring from this effort, I proceeded with the lines on the east and north of the mountain carrying them up in each case as far as possible to the base of an inaccessible cliff, which skirts all the east and northeasterly face of the mountain.

While engaged in this work, I had the misfortune to smash my Watt's transit rendering it practically useless. One of my men who was helping me up the mountain with it fell, and, while he was not seriously injured, the transit was broken by having the main spindle broken, so that the head with the upper plate rolled one way while the tripod and lower plate went with my assistant.

A heavy growth of timber fills the river valley and the lower slopes of the mountain as far north as the north boundary of sections 20 and 21, township 27, range 12. From this point north there is a heavy forest of fire-killed spruce and pine, standing for the most part, but rapidly falling and covering the ground with a tangled mass of logs and limbs. In some places south of the aforementioned boundary of sections 20 and 21, fire has gone through and killed the timber which has fallen, and a new growth of apparently about twenty years has covered these areas. The tangled masses of fallen timber on the sides of the mountains make climbing and running lines extremely slow and difficult. We found little pasture for horses until after passing into the fire-killed section to the north where the grass is very good.

In order to get at the unfinished lines on top of and on the westerly slope of the mountain, I opened a trail from Cascade river southerly along the valley between Cascade and Sawback mountains. The camps along the trail were from one to three miles from the work, but were the most convenient I could get, and necessitated a climb every morning up the side of a mountain covered with fallen timber.

A greater part of the actual work was above the timber line between seven and nine thousand feet above sea level. When I arrived at the southern end of this valley between Cascade and Sawback mountains, I was forced to open a trail over Stony Squaw mountain, or return as I had come in by a thirty mile detour to make two miles. I accordingly opened this trail, and with a little work it would make a much shorter and easier route from Banff to the Panther creek and Red Deer sections of the mountains to the north of Banff.

All of the country surveyed east and northeast of Cascade mountain has been prospected and many seams of coal were seen on which more or less work had been done. On one stream in section 29, township 26, range 11 and section 25, township 26, range 12 fourteen different openings all showing coal were seen.

We had few accidents with the pack train but found it both necessary and difficult to keep shoes on the horses. The dead timber made trail making difficult and was extremely hard on pack sacks and covers. Some of the horses were rather severely snagged but none were permanently injured.

One thing that impressed me, was the scarcity of game in the more outlying parts of our work. More game was seen between Banff and Bankhead and between Banff and Canmore, than in any other part. Evidences of game having been killed were seen and shots were heard while in the Cascade river valley, but the hunters were never seen. I am inclined to think that they were Indians as they did not enter the valley by the trails ordinarily in use by the residents of the district. Cascade river valley is an ideal place for deer, sheep and goat but the scarcity might be accounted for to some degree by the fact that we saw both grizzly bear and mountain lion there. I think more thorough protection of the game should be exercised if it is desired to make the Park a breeding ground.

The following other surveys were also made :—

1. John Brewster, lease.
2. Lots at lake Minnewanka.
3. Grandview villa lots.
4. Traverse of Bow and Cascade rivers in township 25, ranges 11 and 12.
5. Correction to survey of east boundary of section 23, township 24, range 8 and retracement of the south boundary of the Indian reserve across the same township.
6. N. K. Luxton, lease of villa lot.
7. Resurvey of various villa lots in Banff.

In making the traverse of Fortymile creek for the John Brewster lease, two days were spent in looking for an old post or monument on the north boundary of the old park without success, but after the snow had disappeared a post was found burnt off. This country has all been burnt over since the old survey. I found no mound in retracing 119 chains of this line southwesterly from the creek, although such are shown in the old notes and plan.

In the traverse of Bow river we found the Canadian Pacific railway employees building a dam near the middle line of township 25, range 11 to deviate the river through a canal, which they have constructed. This deviation will do away with two bridges on the railway line, if the river can be made to take and hold the new channel. These improvements are noted in the traverse. As the river was partially frozen but not sufficiently so for us to cross on the ice, we were handicapped to a certain extent in the traverse work. I completed all the work for which I had instructions on Saturday, November 24, disposed of my outfit on the 26th and left for home on the same night, and arrived in Brantford on December 1.

I have the honour to be, sir,
Your obedient servant,

C. C. FAIRCHILD, *D.L.S.*

APPENDIX No. 22.

REPORT OF LOUIS E. FONTAINE, D.L.S.,

SURVEYS AND RESURVEYS IN CENTRAL ALBERTA, INSPECTION OF CONTRACTS IN CENTRAL AND SOUTHERN ALBERTA.

LÉVIS, QUE., January 28, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR.—I have the honour to submit the following general report concerning my survey operations in Alberta during the past season, under instructions from you dated April 19, together with subsequent instructions of June 15 and September 29.

I left Lévis on April 24 and proceeded to Edmonton, Alberta, where I was to organize my party. For a few days following my arrival I was engaged in collecting transport outfit, overhauling the same, engaging men, ordering supplies and completing the organization. By this time the spring rains had set in, thereby making the roads soft and miry; and as most of the horses were fresh off the range, I was obliged to postpone my departure. Eventually, conditions being favourable, I left Edmonton and proceeded by way of Sprucegrove, Stonyplain and Mewassin, and from there to the northwest quarter of section 31, township 50, range 3, west of the fifth meridian, where I was to begin the restoration survey in the said township and range.

In proceeding with the work, I must say that the lines previously run were so obliterated that all attempts to follow them throughout proved futile. The only vestiges being in the islets of green timber spared by the lumbering operations and fire. The charred or rotten remains of posts were generally buried under a thick accumulation of hay, leaves, wood and moss.

While operating in this township, I must say that Mr. Bruin gave us great attention. His first move was to totally destroy a cache of supplies, and following his clue handled my transit very roughly, during our temporary absence from the line. However, as I had an ample supply of provisions stored at a farm house on the north side of Saskatchewan river, and also a second transit, the inconvenience and loss of time resulting thereby amounted to only two days.

A detailed report as to the general resources of this township will be found in the official field-book.

My next move was to proceed to Edmonton, where I made a stay of two days for necessary repairs to the transport outfit, and the ordering of supplies; thence left to carry out operations as instructed by your letter of June 15.

These operations were of a varied character and consisted mainly in the taking of observations, investigating the marking of certain boundary corners and completing the traverse of certain lakes. As this was done in no less than fourteen townships, I think it would be superfluous to enumerate each of them here, as the returns show fully what was performed in each case.

In order to achieve the purpose in view, I had occasion to cross this section of the province of Alberta, comprised between the fourth and fifth meridians, and townships 37 to 52.

While performing this journey, I may state that it was hardly conceivable what great changes had taken place in this district since my first visit in 1898. Then a farm-house or a ranch would be found only every thirty or forty miles, whilst at the present time you are never without sight of the one or the other. Moreover, in several townships, not a quarter section is to be had for settlement and instead of what was formerly a vast wilderness, beautiful fields of waving grain are to be seen in all directions. Settlers are continually coming into this very fertile district, and day after day they are to be met with on the main trails making their way to their new homes, with wagon loads of their implements and effects.

Access is very easy to this district and it is traversed in several directions by a number of good main trails, and ere long it will have good transportation facilities by rail. Two of the grading outfits of the Grand Trunk Pacific were met, one in township 43, range 1, and the other in township 44, range 6, both west of the fourth meridian. On the other hand, trial location lines for the extension of the Lacombe branch of the Canadian Pacific railway, are staked in townships 38, ranges 7 and 8, west of the fourth meridian. The same company is also engaged in building an extension bridge across Battle river, at Hardisty, and it was proposed to complete the grading on the east side of said river to a distance of fifteen miles before fall.

In this section, fresh water is to be had in almost all lakes and sloughs. In boring wells, good water is obtained at almost any place at a depth varying from ten to forty feet.

During the course of last season, a vast area in this section was devastated by prairie fires, thereby causing more or less damage to farmers and stockmen. On two occasions, during the night, I had to waken up the whole crew and set it to work burning fire guards around the camp premises, and I may say that if these precautions had not been taken in the proper time, the whole of the transport and camping material would have been destroyed.

Wood for fuel, although in limited quantities, is obtainable in the ravines of most of the creeks emptying into Battle river. On the other hand, good coal veins are to be found in several places; some of them are being operated by private capital and the output from the same, at present, is sufficient to supply the local demand.

Having given a brief description of the territory traversed while carrying on operations called for by the second portion of your instructions, I will now resume the general trend of my report.

On October 5, I left Lavoy, one of the distributing centres of the Vermilion district, situated eighty miles east of Edmonton, on the main line of the Canadian Northern railway, and proceeded to Sullivan lake, where I was to begin the examination of survey contract No. 22.

In these townships adjacent to the lake, I carried on the operations called for and then went to Red Deer river, where three townships forming part of the same contract were to be subdivided. On my arrival, I learned that the contractor had left after subdividing township 28, range 18. Accordingly I examined the said township and then proceeded to Chin coulée, by way of Gleichen and Lethbridge, to examine contract No. 5. The necessary operations were duly carried on, and on their completion, I left for Calgary.

On my arrival there, the season being so advanced, and the horses so fagged by so much moving that I decided to cease operations for the season. I therefore made arrangements for the wintering of the horses and transport outfit. I then left for Edmonton, and there discharged the party on December 12.

After providing for the storing of part of the transport outfit left here in August, I left for home, where I arrived on December 23.

I have the honour to be, sir,
Your obedient servant,

LOUIS E. FONTAINE, *D.L.S.*

APPENDIX No. 23.

REPORT OF GEORGE A. GROVER, D.L.S.

RESURVEYS IN MANITOBA, INSPECTION OF CONTRACTS IN EASTERN MANITOBA.

KINGSTON, ONT., January 28, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR.—I have the honour to submit the following report upon my survey operations for your department during the past season.

Under your instructions dated April 12, 1906, I left home on April 23, and arrived in Winnipeg on the 25th.

Winnipeg, as usual, was full of activity, and the hotels were crowded. It is a wonderful market both for men and supplies, there being plenty of work, and plenty of men and the stores carry stocks of goods that twice the population would scarcely warrant in the east. I spent a couple of days there getting supplies and engaging my party and then proceeded to Teulon to pick up my outfit, which I had stored there at the close of the previous season.

For some years past Teulon has been the 'end of steel' on the Stonewall branch of the Canadian Pacific railway, but this year they were extending the line farther north, purposing, I believe, eventually to run to Icelandic river, on lake Winnipeg. This should prove a profitable line, for though the country is at present largely broken by marshes and swamps, these should gradually diminish with deforestation, and the soil in nearly all parts is excellent.

I do not fancy that this country will be a great wheat growing one, at least for many years to come, but it would seem to be well adapted to mixed farming and dairying. For the poor man a wooded country is preferable to the prairie, as he has building material and fuel at his door and can make his home for his labour. The proximity to the great and rapidly growing market of Winnipeg will also assure the settler of a demand for his products and guarantee him his necessities at fairly reasonable prices.

The Canadian Northern railway is also extending, or talking of extending, its line along the shores of lake Manitoba from Oak Point. This should also prove a valuable extension but there is a wide stretch between the two lakes (Winnipeg and Manitoba) that neither road seems desirous of entering, why, I do not know unless for economic reasons of their own. It is a fertile country and fairly well settled, particularly when its distance from the railway and the difficulty of road travel are considered. Moreover this should be a cheap country to build a road through, there being no great engineering difficulties to overcome. Transportation is the question of the hour from London's most crowded boroughs to the sparsely settled portion of our great West.

In this country moose, elk, deer and other large and small game as well as wild fowl and ducks are plentiful. In the fall the woods are infested with hunters and, owing to the vague ideas which some of them have of the appearance of game, they lend a spice of excitement if not of actual danger to our work.

This country to the north of Teulon is quite a characteristic sample of the West and conveys a good idea of the heterogeneous nature of our immigrants. Here one finds all classes and conditions of men jostling elbows. Norwegians, Swedes and Finns from northern Europe living as neighbours to the French, Galicians and Spaniards from the southern half of the continent and the whole leavened by Americans, English and Canadians (both French and English speaking), not settled in separate colonies but all the different races side by side. This commingling of races, while very interesting from an ethnological view point, causes some real difficulties in practical government. Very seldom do a man and his immediate neighbour speak the same tongue and though they may have a knowledge of English it is in most cases not a very intimate one and it is almost impossible to avoid constant bickerings that are quite unnecessary. Each race has an inborn distrust of the others which nothing will entirely overcome. Add to this the difficulty any man finds in expressing himself adequately in any but his mother tongue and the consequent misunderstandings afford a difficult proposition indeed. The wonder is not that the immigration and other officials have difficulties but rather that they have been able to cope with them so successfully on the whole. We can only hope that the next generation or, if not, at least the third will gradually forget their old world jealousies and mistrusts and grow to understand that we are all Canadians with a common future no matter what our past may have been.

I spent a day or two in Teulon getting my outfit overhauled and my stores collected and proceeded north into my first work where I arrived on the 3rd day of May and on the following day started my season's work in township 19, range 1, west of the principal meridian. This township, though stony in places, has excellent soil and one settler stated that he had grown fifty bushels of onions on a patch about fifty feet square. He assured me that all kinds of vegetables and grain do remarkably well here. There are two or three large marshes in this township which supply hay and water for the cattle.

Township 20, range 1, west of the principal meridian, was the next visited, and it is very similar to its neighbour to the south, with the exception that no considerable marshes are met with.

In township 20, range 2, west of the principal meridian, there seemed to be less stone, but the marshes were large and deep.

Township 19, range 2, west of the principal meridian, is similar to its northerly neighbour, but there is less stone and less marsh land.

Township 18, range 1, west of the principal meridian, has perhaps more stone than any of the other townships visited in the vicinity, but practically all the homesteads are occupied, and the settlers seem to be able to easily clear their land.

In township 18, range 1, east of the principal meridian, the settlers are not so far advanced owing to the lack of roads and the rather heavier bush, but the soil is good, and I think a few years will witness quite an improvement.

In all these townships, I had the previous year retraced Mr. Martin's lines, and this year was making the re-subdivision complete, rendered necessary by the gross errors in the original survey, the great discrepancies between it and Mr. Martin's resurvey, and the fact that all the old posts were lost. Many of the settlers expressed their appreciation of the work, and I hope it may help to a more peaceful understanding among the various people, although I think some of them would hardly be satisfied unless the government carefully fenced their land and gave it to them.

The settlers in all these townships seem to be getting along nicely, and in township 18, range 1, west of the principal meridian, there are some very good farms and a nice little school has been built recently. Although they are a long way from the railway, one settler has a threshing machine, and there is considerable grain grown. Most of the settlers, however, have so far contented themselves with clearing their land, putting up buildings and attending to a garden and a few cattle, which latter represent their savings when they hire out, as most of them do, for part of the year.

The timber in this country makes good fuel and temporary buildings, being mostly poplar, though there is a little spruce in some places. A good deal of poplar is cut and shipped into Winnipeg as cordwood.

In several places we saw outcrops of limestone of a creamy colour, which was said to make first-class lime, and from all appearances would make a good building stone if it could be marketed.

In the rush west this country seems to have been overlooked, but I think from now on there should be continuous, even if somewhat slow, progress.

On July 10, I started from township 18, range 1, west of the principal meridian, to move into township 22, range 7, west of the principal meridian. We went by way of the trail around the head of Shoal lake to Oak Point, and thence by the Colonization road to Scotch bay, and from there used settlers' and Indian trails, none of which were very good.

We had a peculiar season, in that the spring was remarkably dry, and heavy rains did not commence until late in June and continued well into July. This spoiled the roads just at the time we wanted to use them, but in one way was a blessing, for the mosquito crop was unusually light.

Along the shores of Shoal lake and between that and lake Manitoba is a fine pastoral country composed of great hay meadows or flats, with just enough bush to shelter the stock, and most of the settlers were engaged in cattle raising and dairying.

Oak Point is situated in a park-like piece of country, with oak clumps and prairie alternating, and facing on lake Manitoba. For natural beauty it would be difficult to surpass, and I believe man is to do his part and will soon turn it into a beautiful summer resort.

This country has been settled for some time, and I met several farmers who had started with nothing and now own well stocked farms of from one hundred and sixty to four hundred and eighty acres, cattle forming a large part of their assets.

Cream is shipped from here to Winnipeg in large quantities, which will doubtless increase when better facilities for handling are provided.

Travelling north the country gradually becomes less open and the bush changes to the familiar poplar once more. The trails get gradually worse as the limits of settlement are reached, though I must confess I saw them at their worst, which means well nigh impassable.

Reaching township 22, range 7, west of the principal meridian, on July 14, I found that only two or three families were in actual residence—the others awaiting the resurvey to get accurately located. An examination of the south boundary of the township showed that I must be prepared for very unusual work, and I was therefore not surprised at the condition in which I found the interior lines.

I ran a trial line the full six miles across the south of the township to give myself a base from which to work, and from it I laid out my meridians to join the section corners on the south outline with those on the north as closely as possible. It was impossible to correct the old survey without interfering with the adjoining townships, and I consequently was forced to modify my work by the old corners when I found them. This gave most peculiar results, as my technical returns show, but I left good monuments on the ground, and gave correct chainages and azimuth between them, which was about the best I could do.

This township, township 22, range 7, west of the principal meridian, is well suited for mixed farming and dairying, the soil being a rich black loam with clay subsoil. The surface of the country is gently rolling and is well timbered with poplar, some of good size, on the ridges and interspersed with hay meadows in the depressions. This alternation extending as it does through the township gives plenty of building material and fuel and good feed for stock. Game was fairly plentiful and some of the settlers catch a good many fish in lake Manitoba.

From township 22, range 7, I proceeded, in consequence of your instructions, into township 22, range 8, west of the principal meridian, the east outline of which had been re-run in connection with the resurvey of the former township. To get into township 22, range 8, we passed through the Sou Sonse Indian reserve, which is a very pretty piece of country along a fine sandy beach on lake Manitoba. The road along the shore is picturesque and park-like in the extreme and the adjoining land raises hay in abundance though the Indians seem to disdain the cultivation of any of it. They keep a few cattle and live chiefly by fishing and hunting. I fancy that with the advance of civilization they will want to move farther back, which would open a nice piece of country to settlement.

Township 22, range 8, is largely broken into by this reserve and, as I had no instructions to re-run the reserve boundaries and the old lines were lost I judged it best to keep at a safe distance from it. At the same time I placed sufficient corners to guide the settlers in their choice and closed all my surveys. From here I proceeded, as the season was well advanced, to the inspection of certain contracts of 1906 in accordance with your instructions.

I made my first inspection in townships 23 and 24, range 7, west of the principal meredian, being part of contract No. 6 of 1906, held by Mr. J. L. R. Parsons.

To change from re-tracing old lines run twenty years ago to inspecting present day contract work is, I fear, not in the interest of rigid inspections. There has been such an improvement, not in any particular, but in every detail of the surveys made in this country in the past twenty years that one would hesitate to speak of them as being the same class of work. In no way could the advantage of the numerous changes in the manual and in the field instruments used, be more markedly illustrated than by this change which I was forced to make this season.

The lines examined in contracts of 1906 were straight, the chainage good and the corners were well marked, none of which could be said, as a rule, of the more ancient surveys in this country. I had, I may say, one pleasant surprise during the summer when I re-ran a meridian outline, run thirty years ago, and checked almost precisely both in azimuth and chainage but this stood out as a brilliant exception to the rest of those surveys.

On the contrary I found the surveys of to-day very satisfactory in every case; the clause regarding opening and blazing of lines was not always interpreted according to my ideas but in all other respects I thought the work was generally creditable both to the contractors and to the department and I cannot conceive that any such surveys as I have been retracing could be passed so long as the present system is enforced with intelligence and honesty.

From township 23, range 7, west of the principal meridian I proceeded south via Oak Point, Stonewall, Winnipeg and Ste. Anne to my inspections in southeastern Manitoba. When passing through Winnipeg I dismissed three of my party, reducing its strength to six, exclusive of the cook and myself, which I found ample for inspection purposes.

The roads were by this time in good condition and I had no difficulty in moving, but the carts which I was using did not allow great speed. I have used these carts now for two seasons and, though they have merits, I think on the whole wagons are preferable and they are much more readily replaced.

In travelling from Oak Point to Ste. Anne I rested over Sunday on the southwest shore of Shoal lake and, calling on one of the settlers in the afternoon, I was surprised to note quite a pan full of salite or crystalized salt which he informed me had been deposited in his kettle through evaporation of water. His well was only a few feet deep and I was led to wonder if valuable salt solutions might not be found at greater depth. The settler himself was unaware of the nature of the mineral until, at my suggestion, he tested it. He had not noticed any salty flavour to his drinking water but to me it was quite perceptible. His house was on a rather sandy ridge quite close to the shore of the lake.

From Ste. Anne I proceeded along the Dawson road to the contracts reached by it. The road itself I found in good shape there having been considerable grading done on it and the small bridges being kept up by the farmers. The piers of the old bridge on Whitemouth river are still visible but are in a ruined state, the superstructure having disappeared. However, at the time I reached it the river was not difficult to cross there being good bottom with water not over three feet deep and the approaches were not too steep. Sportsmen are the chief inhabitants of this country though there are a few settlers and an occasional lumber camp.

After inspecting contracts Nos. 6 and 4, I moved south through contract No. 10, inspecting it on my way to Woodridge, and from there went by the trail running almost due east into contract No. 3. I inspected this contract and continued south on the west side of Whitemouth lake, through Vassar and Pine Valley into townships 1 and 2, ranges 10 and 11, east of the principal meridian, being part of contract No. 7.

Whitemouth lake is a fine open piece of water, with a fringe of hay meadow or marsh along the shore. At the time I was in the vicinity there were great numbers of wild geese on the lake, but it was difficult to get close enough to kill them.

Vassar is only a station, but there is some settlement in the neighbourhood.

Pine Valley is the name given to a small settlement adjoining Piney station on the new Canadian Northern extension from Emerson to Sprague, nearly parallel to the international boundary, known as the Ridgeville branch. This branch has been in operation only for a short time. At Pine Valley I met several contented and prosperous settlers, doing well in a country that a few years ago was principally swamp. This place seems to be settling up rapidly, and there seems to be some good land in the vicinity.

The difficulty in southeastern Manitoba is to distinguish the good land from the bad, so much of it being covered by moss and swamp, under which the soil may be good or may be very sandy, as it is in many places.

While we were camped in township 1, range 10, east of the principal meridian, the big blizzard of November 16 caught us. Fortunately we were camped in a sheltered spot, but I was forced to buy hay for my horses, as the feed was very meagre before the storm and, with five feet of snow, it was almost impossible for them to get anything.

I had previously thought of storing my outfit in Pine Valley, and this storm quite decided me to do so, as it was ridiculous to think of starting on a long move through the snow with carts. I therefore stored my outfit in Pine Valley and took train for Winnipeg, where I discharged most of my party, retaining only my cook and two other men to finish the season.

For the inspection of scattered contracts a small party, with the use of railway and hired transport, is expeditious and, I think, economical for the department, but not for the surveyor paid by allowances.

I then proceeded by train to Makinak, purposing to inspect contract No. 9, but on my arrival I learned that the contractor, Mr. Dumais, had left the work early in the summer on account of water, after doing very little work, and had not returned. I therefore thought it would be a waste of time to go farther, so I took the next train to Grandview, where I hired a team and drove out to the inspection of contract No. 5.

We were engaged on this work while the weather was quite severe, and I was surprised to see the threshers working outdoors with the thermometer about 30° below zero and a couple of feet of snow on the ground.

The land in this vicinity is, however, excellent, and this year between heavy crops and additional acreage the threshers were quite unequal to the demand, and consequently had to make a long season of it.

This country is well settled right up to the borders of the timber reserves, and the settlers seem to be doing well. They are largely Canadian, English and American, and are very progressive, Grandview being quite a good sized town with every appearance of prosperity.

After completing the inspection of contract No. 5 I returned to Winnipeg and proceeded to Lac du Bonnet to the inspection of contract No. 8. Finishing this, I returned to Winnipeg, discharged the remainder of my party and took train for the east, arriving home on December 24.

I have the honour to be, sir,
Your obedient servant,

GEO. A. GROVER, *D.L.S.*

APPENDIX No. 24.

REPORT OF A. H. HAWKINS, D.L.S.

SURVEYS AND RESURVEYS IN SOUTHERN SASKATCHEWAN AND SOUTHERN ALBERTA.

LISTOWEL, February 26, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour in accordance with my instructions, to submit the following general report on surveys performed by me, during the season June to December, 1906.

Upon receipt of your instructions dated May 15, 1906, I began at once to prepare for the season's work, by opening correspondence with your department, relative to securing instruments that would enable me to perform the work with the greatest degree of accuracy possible. Upon receipt of my sidereal time piece, I left my home in Listowel on June 7. en route to Medicine Hat, via Owen Sound and Canadian Pacific Railway steamer *Athabaska* for Fort William, and from thence by rail to my destination, where I arrived June 11. I at once set to work to secure the necessary outfit, in which work I was materially assisted by Mr. F. G. Foster, mayor of Medicine Hat, and Mr. L. B. Cochrane, government agent.

The work of organization was somewhat slow, as there was no horse market in this place, and every person owning animals seemed anxious to dispose of them, at what appeared to me fancy prices, but after a thorough canvass of the material offered, I selected three teams, that I thought would be what was required, and which proved an excellent lot for the purpose. The other parts of my outfit were more easily secured. Plenty of men offered themselves as labourers, but careful selection is very necessary. A cook, however, seemed impossible, and I did not get as good a man during the whole season, as the wages offered should have secured.

On June 21, we started for our first work, being the subdivision of township 2, range 29, west of the 3rd meridian. We travelled south along the valley of Bullshead creek, intending to cross Cypress hills, via the Royal Northwest Mounted Police post lodge, but at 2.30 p.m., a rain storm started in, that turned the trails to streams of mud, and we camped in a settler's vacant cabin, where we remained until the morning of the 23rd. The trails were very soft, so that I put four horses on my heaviest wagon, and trailed the buckboard. Several bridges had been washed out, and the trails were very heavy, so that our progress was slow. The rapid settlement, and consequent fencing of old and opening of new trails delayed us somewhat, but we arrived at our destination on the evening of the 26th and camped on Middle creek in a pasture owned by Mr. E. Peachy, who kindly gave his permission.

The country in the vicinity of Cypress hills is fairly well settled, and considerable attention to mixed farming seems to be the rule. South of the hills, however, settlers are much more scattered, and cattle or horse raising seems to be the more profitable and popular employment, and the soil seems to change in character. South of the hills is a heavy clay, with considerable stone, while the immediate vicinity of the hills is more of a loamy nature.

Township 2, range 29, west of the third meridian, is a rolling prairie, traversed its entire length by Middle creek, and across its southwestern portion by Lodge creek. The soil is generally third and fourth class, and is a hard clay with numerous very stony patches, except the valleys which are comparatively narrow, where it is a clay or sandy loam, easily cultivated and very fertile but subject to inundation during the spring, as these streams, as is the case with all prairie streams, rise and fall with great rapidity.

There are three settlers in this township, Mr. Peachy in the north, Mr. M. Lynch in the centre and Mr. D. A. Hammond in the southern portion of the township. Mr. Peachy has a very fine band of Percheron horses, numbering some 80 head, as well as some 200 cattle. Mr. Lynch and Mr. Hammond have each about 250 head of cattle, and all doing well. All three of these gentlemen are working on irrigation schemes, their object being to cultivate as much of the bottom land as possible, in order to raise feed for the more efficient wintering of their growing herds, and which I have no doubt will add very materially to their prosperity and to the value of their holdings.

There are several other very desirable locations along these valleys for small ranchers, and I am informed that there are some very excellent and prosperous locations on Middle creek, to the north of this township.

All of these settlers, and Sergeant Allan of the Royal Northwest Mounted Police testified as to the excellent garden produce raised in the valleys, so that I am quite sure, that cultivation only is needed to raise what hay, grain or vegetables are required.

There is no timber in this township, a few bunches of willows, from 1 to 2 inches in diameter, being all we found, but timber may be obtained for fuel or for building purposes in Cypress hills and at present a sawmill is in operation there, and distant from 40 to 50 miles from the township.

Coal may be obtained at a place some 10 miles south of this township, in the state of Montana, where the settlers dig out what they require. It is easily accessible, and appears to be sufficient in quantity, and a fairly good lignite, containing however considerable sulphur.

The grass on the uplands is nearly all blue-joint, and appears to be very nutritious, but rather short, indeed that cut for hay in this vicinity would average only from four to six inches in length.

Fairly good trails lead from Medicine Hat and Maple Creek to this locality, and a good trail leads from Havre, a station on the Great Northern railway, which is some thirty miles to the south.

Upon the completion of this township we crossed Lodge creek and started westward for our next work in township 1, range 8, west of the fourth meridian passing en route some of the finest hay lands seen by the writer during the season. These lands lie along both sides of Sage creek, and were covered with a heavy growth of blue-joint and pea-vine, eight to ten inches high at the time of my visit, and very luxuriant.

This country is all a rolling prairie, the land, however, apparently improving in quality as you proceed westward.

As Milk river is approached, the surface becomes more rolling and rugged, and broken by small coulées leading into Lost river (which flows into Pakowki lake) and into Milk river. The retracement of the east boundaries of townships 1, 2, 3 and 4, range 9, and the survey of the east boundary of township 1, range 8, now engaged our attention. I regret to have to report that I found a want of care characterizing a large portion of this work. For example, the post marking the southeast corner of section 1, township 3, range 9, on the north side of the correction line, was on the south side of the road allowance, and marked for section 36, and the existing monuments do not appear to be in line. The trails at this season of the year are all in first-class condition, and there is apparently considerable traffic.

This appears to be the heart of the ranching or cattle raising country, and large herds were frequently met, both in the valley and on the uplands, and the headquarters of the Spencer Brothers, Pruitt, and Milk River Cattle company, are in the immediate vicinity, besides a large number of smaller concerns along Milk river.

The Pend d'Oreille police post is also located in the valley of Milk river, in township 2, range 8. Many deep coulées, extending both to the north and south of the river, cut the townships, giving the surface a somewhat rugged appearance, but affording most excellent shelter for cattle and horses during the winter.

Pend d'Oreille coulée, extending from Milk river to Lake Pakowki, is perhaps worthy of special comment. Apparently during very high water in the lake the outlet is this coulée. It averages one-half mile wide, and the soil is apparently a very fertile clay loam, as at the time of my visit it was producing a most luxuriant crop of blue-joint, and was, of course, a great rendezvous for thousands of cattle, and no doubt within a short time will be brought under cultivation.

Rattlesnakes were found in townships 1, 2 and 3, range 8, where we killed no fewer than half a dozen, one of them measuring five feet in length, and, strange to say, no trace of them was found elsewhere.

The best way to get into this country is by trail from Coutts, a station on the Alberta Railway and Irrigation Company's railway, or from Selby, a station on the Great Northern railway, in the state of Montana. From either place good trails lead to all parts of this country.

There is some wood to be had for fuel in the various valleys, but coal is the chief fuel, and apparently abounds throughout the entire country. Seams that have been disintegrated by weather and frost were observed in nearly all of the deeper coulées, and in one on the west boundary of township 1, range 8, where the earth and other foreign matter had been cleared to some extent, we were able to help ourselves to what fuel we required. It appears to be of the lignite variety, and is largely impregnated with sulphur.

Sandstone is abundant in the coulées on the south side of the river, and in many cases is quite hard enough to be used as building material.

The country along the south boundaries of townships 1, ranges 8, 9, 10 and 11, is very rolling and rough, being crossed by spurs and coulées from Sweetgrass hills. The coulées were nearly all dry at the time of my visit, but springs yielding very excellent water were found on several occasions. A number of settlers are located on these coulées and cultivate the bottom lands with fair success, but general farming without irrigation appears to be out of the question.

Besides resurveying the south boundaries of townships 1, ranges 12 and 13, there was considerable retracing on each of them, so much so, that in accordance with your further instructions, I made a resurvey of township 1, range 13. The original subdivision surveys in these townships appear to have been rather carelessly performed, as lines were not straight, distances not as shown, and several monuments noted had never been constructed at all. Probably it would have been better had the resurvey been extended to township 1, range 12. The south boundaries of townships 1, ranges 8, 9, 10, 11, 12, 13 and 14, were all more or less out of position, indicating great want of care, and all the township corner posts planted in this survey were wrongly marked. Township 1, range 14, is not so rolling as the other ranges, but otherwise similar conditions obtain. This whole country, in the writer's opinion, is admirably suited to cattle raising, and is but very indifferent farming land, judging from the poor crops produced in township 1, range 13, and in three different places, where cultivation was tried on the uplands.

Milk river flows through the northeast of township 1, range 13, and waters the northern portion of township 1, range 12, thus providing water for the numerous herds of cattle to be found in this locality. Wood for fuel may be obtained in places, and with a little development work coal could be mined, as indications were seen in several coulées in this neighbourhood pointing to the fact that a bountiful supply was near at hand.

There is a great abundance of sandstone in townships 1, ranges 12 and 13, and especially in the vicinity of 'Writing-on-Stone' Royal Northwest Mounted Police post. The softer parts have been removed by erosion, leaving the rock in all sorts and conditions of pleasing and fantastic shapes, forming a very beautiful and picturesque sight. The sandstone is easily quarried, and is an excellent and abundant building material. All of the settlers with which the valley is dotted use it to a greater or less extent in their building operations for cellars, foundations and outbuildings.

Leaving Milk river, we proceeded west, to the Alberta Railway and Irrigation Co's railway, and thence northwesterly along the road to Brunton station. The country as far as the ridges is similar to that already described. After crossing the Milk river ridges, which lie from four to six miles south of Brunton, the land appears to improve in quality as witnessed by the more luxuriant growth of grass, and some excellent crops raised in the vicinity of Brunton.

From Brunton we proceeded north to Etzikom coulée, where we camped, in order to retrace certain lines in townships 6 and 7, range 17. The subdivision of these townships appears to have been done in a very indifferent manner, as shown by the notes returned of the retracements made, and I am of the opinion that the entire township would have to be retraced, to eliminate the errors. If I might be allowed, I would suggest the very great desirability of a resurvey in these two townships, as nearly every line retraced was found to be different to the returns sent in, both in chaining and azimuth.

These two townships are generally good soil, and I think will very shortly be cultivated, and form an important addition to the producing lands in this district.

Several claims have been located, but only a small amount of land, as yet, has been cultivated, but probably during 1907, the amount will be very largely increased. Coal is the only fuel. It is to be had at Stirling, a station on the Alberta Railway and Irrigation Co's line, and ten to fourteen miles distant over the very good trail following the Etzikom coulée, although one settler informed me that he knew of a seam of lignite in township 6, range 16.

Our next work was to make an examination of the third correction line, ranges 22 to 26, and we passed through Stirling and Lethbridge en route. Stirling is the centre of a new Morman settlement, and appears to be in a thriving condition. Here all men are brothers. From what I could learn, the settlement extending westward from this point, is in a prosperous condition, and I am credibly informed, they as good Mormons will help one another in all possible ways.

A large beet-root sugar factory at Raymond, some six miles west of Stirling, has opened up a large industry, that men, women and children of this settlement all assist in making a success.

Irrigation schemes are being pushed in all directions, and the excellent produce of all kinds, testifies to the fertility of the soil when properly watered. As you near Lethbridge, several large irrigation canals are passed, and the country assumes a still more settled aspect. Good buildings, larger stacks of grain, and more fences mark the advance of civilization.

We spent one day in Lethbridge, replenishing our provisions, horse food and fuel, and shoeing our horses, and attending to several minor repairs, and making a short call on the agent, Mr. Martin. We then started for the third correction line, and here again we found somewhat careless methods of surveying very much in evidence, and the positive instructions given in the Manual to make the line joining township corners a true line, evidently disregarded, as the line joining the monuments, on several occasions, was anything but straight.

The road allowance in one place was but fifty links in width, and was corrected and widened, as much as circumstances would permit. Only a few of the original posts were found standing along these lines, and I was informed that the same conditions existed throughout the adjoining townships. Partially obliterated pits, sometimes quite difficult to find, were generally the landseeker's only guide, causing him at times much trouble to ascertain his location.

An error of ten chains was found in the east boundary of sections 6 and 7, township 11, range 22. As no lands were patented, and the only improvements affected were plowed land and some fencing, the latter of which in any case would have to be renewed in the course of two or three years, and as the settlers would neither consent nor refuse to have the change made, I dug pits on the east boundary of these sections, in the proper positions. It appeared to me to be too bad to leave so glaring an error which might cause costly and useless litigation in the future when correction could now be so easily made.

The country along this third correction line, is fast settling up, and will in a very short time become a factor in the wheat producing districts. The soil is a clay loam, and apparently very fertile. The land has been taken up within the past three years, and even in so short a time many fine farm buildings and houses were noticed, and one hundred acre fields were seen quite often, all testifying to the productiveness and fertility of the soil. Very few quarters of available land were vacant, and all held their lands at from $17 to $25 per acre, when for sale at all.

Fuel is an item in the domestic economy of settlers in this region that presents a very serious obstacle. During the time of my visit in the early part of November, on several occasions I heard settlers pleading with the coal dealers in Leavings and Claresholm to let them have a little coal, and although there is an abundance in the neighbourhood, the settlers seemed unable to get it. The Black Diamond mine, east of Lethbridge, had contracts for all they could produce, and the strike at Lethbridge and a broken cylinder head prevented them from producing the usual supply. Indications of coal were observed in section 7, township 11, range 22, where a well had been sunk some twenty-seven feet, and shale having the appearance of close proximity to coal was found. Also on Rocky coulée, running north and south through township 10, range 24, some prospecting had been done, but not sufficient to strike a good seam. I was informed that about two miles north of the correction line in township 11, range 22, coal had been dug, where it was exposed very near the surface. It seems a great pity that settlers should be at the mercy of coal companies and strikes, when so much material is so near at hand. The development of this coal would remove a great obstacle to the complete and very prosperous settlement of this splendid tract. All the settlers we met seemed to be hopeful and prosperous. One young Englishman who had been on his claim two years, and started with nothing, had some eight hundred bushels of wheat, besides two hundred or more bushels of oats. He was living in a small shack, but felt that he was on the highway to prosperity, and the same air and spirit was noticeable all through the locality.

The road along the third correction line leads directly into Leavings, a station on the Calgary and Edmonton branch of the Canadian Pacific railway and during the time of my stay, from five to ten wagons per day, loaded with grain, passed us on their way to market. Hay was purchased from the settlers in this locality, as our horses had to be tied up, owing to a large portion of the country being fenced. What remained was eaten very closely by the cattle which are allowed to range on vacant lands. The hay was of good quality, timothy and red top, and appeared to grow luxuriantly,and the farmers in this locality would, I think, have but little difficulty in feeding their animals during the winter.

Potatoes, turnips, carrots and beets are grown all over the district, and from samples obtained appeared to be of excellent quality, and I was informed that the crops were easily raised and abundant.

The want of water is somewhat of a drawback, but most of the settlers now have their own wells that range in depth from fifteen to two hundred feet, and while some appeared to be tainted by the proximity of coal, the water is generally very good although hard.

Some complaint was heard as to the market not being so satisfactory as desired. When wheat was 52 to 54 cents per bushel in Leavings the same grade was selling for 70 to 75 cents in Winnipeg. The settler thought he was not getting his due, but no doubt continued prosperity and a united action on the farmers' part will tend to do away with this seemingly large difference.

Our next work was some retracement in township 13, range 29, west of the fourth meridian and upon completion of the third correction line we started for Lyndon P.O., passing through the town of Leavings en route. These small prairie towns all give evidence of the prosperity of the surrounding country. There are several good stores in Leavings, where supplies of all kinds can be purchased at about Calgary or Medicine Hat prices. There are also two fair hotels, a butcher shop, a blacksmith shop, livery stables, several churches and a good school. And just here I beg to remark that from Stirling, which is the point where extended settlement begins, northward schools are quite frequently to be seen, and north of Lethbridge the schoolhouse becomes quite a familiar sight.

From Leavings we followed the third correction line to the base of Porcupine hills, and from there along the old '44' trail to Lyndon P.O. which is situated right in the hills, passing en route the fine buildings of the '44' home ranch. The land along this trail is being rapidly taken up, many preferring the protection afforded here to the bleaker locations on the open prairie, and a number of prosperous looking homesteads were passed en route. A large portion of these hills is held by various cattle and ranching companies, and no doubt when their holdings are thrown open many more settlers will take advantage of the opportunity to locate in this district.

Here again I found carlessness in the original subdivision to be the sole cause of making retracements necessary. Although the country is rough and very rolling it should not be an excuse for returning chainages so different to what is actually on the ground, as a little extra time and rechaining would show the surveyor the correct distances, and remove the somewhat disagreeable necessity of admitting errors.

This entire township is very hilly. Trout creek flows along its south boundary and Willow creek along the north, and the summit or divide between the two valleys passes right through the township, and ranges from four hundred to five hundred feet above the creeks. Smaller ravines leading into these creeks cut the surface in every direction making it very rolling and broken. Willow scrub and brush was found in many ravines and on the northern slopes of hills, making the locality, in the writer's opinion, an ideal cattle range, and while the land is of excellent quality the very uneven surface would render extended farming operations difficult. The grass on the hills is largely of the spear or arrow grass variety, of a most luxuriant growth, and seems to be very nutritious, every place not covered by scrub or timber affording fine pasture for stock as well as shelter and water. There is a small quantity of very fine timber in the southwest of the township consisting of fir, hemlock and spruce, and apparently this supply increases as you go farther into the hills. Settlers use wood for fuel here altogether, and have no difficulty in securing all that is required, as well as fence posts and logs for stables and outbuildings. A sawmill is located some five miles west of this township, on Trout creek, and is very accessible by a good trail along the bank of Trout creek. The water is all fresh, and I am credibly informed that during the fishing season both Trout creek and Willow creek afford a bountiful supply of trout of which there appear to be at least two varieties.

Trout creek in this township is hardly large enough to make development of power profitable, but I am told that Willow creek is very well adapted for such a purpose, and has ample water and several rapids that could be developed very readily by the construction of dams.

Sandstone is readily obtainable in the southeast portion of the township in section 1, and I am informed can be taken out in Willow creek also, and apparently is a very good building material, as a number of ranchers have used it for foundations, cellars and small outbuildings.

No minerals of economic value with the exception of lignite were found throughout the season, although as noted in my report of township 1, range 13, Sergeant Gillespie of the R.N.W.M.P., has found what he believes to be petroleum, and at the time of my visit was pushing his investigations to ascertain for a certainty.

Game was very scarce throughout the entire range of my season's work with the exception of coyotes, badgers and foxes, which seemed to abound everywhere. A few antelope were seen while we were in township 2, range 29, west of the third meridian. A few rabbits and chickens were seen at intervals during the season, but ducks and geese were very scarce, no doubt owing to the great want of water in this locality.

Along Milk river, in township 1, range 13, several colonies of beaver were noticed, and although we saw none of these interesting and industrious animals the result of the previous night's work was very frequently in evidence.

Upon the completion of the retracement in this township, I thought it best to disband for the season, as the snow was already deep and the weather cold, the last move we made taking us almost the whole day to go four miles. The ground was too hard to mound whenever exposed, and apparently winter had set in, although the settlers all informed me a chinook wind would come and take away the snow very soon. However, on the 27th of November, I moved out to Mr. Erwin's in section 2, township 13, range 29, west of the fourth meridian, where I stored my outfit, and left my horses in Mr. Erwin's care for the winter. Next day Mr. Erwin took us to Claresholm, when I paid off the party and left for Medicine Hat, and thence home at once.

The question of the rights of the squatter and small settler as against the large lease holder is one that is rapidly becoming a burning issue throughout the grazing lands, and the department will no doubt be called upon before long to clearly define the rights of each. During the season we heard both sides, but the solutions are out of the surveyor's province.

During the season the outfit travelled some four hundred and twenty miles, not including travelling while at work, and generally the trails were in good condition, and horse feed abundant in the vicinity of our camps.

Some three hundred and fifty miles of line were surveyed or retraced, monuments restored, or new ones constructed. The temperature was noted each morning at 7 A.M., and a record of the same appears in my diary together with a short note on each day's weather, &c.

Observations for azimuth and time were taken at every opportunity affording a constant check on all work performed.

The timepiece, Watt transit and four chain steel tapes, all proved to be well adapted to the work required. The transit being especially well thought of, and on clear days, not too windy, the writer had no trouble in finding Polaris at noon, and observations were frequently taken during the dinner hour.

The four chain tape was also found to be of excellent quality and by using the clinometer the roughest country is quickly and accurately measured.

I furnished my chainmen with plummets which were used throughout the work, as I find this method preferable to a drop pin.

The weather was generally very favourable for the prosecution of survey operations. Only three days were lost from rain and one and one-half from snow during the entire season. The high winds that prevail in southern Alberta are somewhat annoying, and require the surveyor to exercise the utmost vigilance to keep his line straight and his chaining accurate.

In closing my report, I wish to express my appreciation of the services of Mr. Paul B. Street, of Toronto, who always performed any part of the work assigned with ability and cheerfulness.

I have the honour to be, sir,
Your obedient servant,

A. H. HAWKINS, *D.L.S.*

APPENDIX No. 25.

REPORT OF ERNEST W. HUBBELL, D.L.S.

RESURVEYS AND INSPECTION OF CONTRACTS IN THE PROVINCE OF SASKATCHEWAN.

OTTAWA, January 22, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following general report of my survey operations in the province of Saskatchewan during the past season.

In compliance with your instructions dated March 30, 1906, I left for Prince Albert on April 17, arriving there late Saturday night, April 21.

On Monday I drove to Mr. J. E. Pollock's ranch, ten miles distant, where my survey outfit was stored for the winter. I returned the following day with both my horses and outfit, the former looking as if they had not been overfed during the winter. My organization station being at Craik, one hundred and seventy-seven miles south of Prince Albert, I considered it more economical to convey my outfit there by rail. Engaging a box-car I loaded my outfit and horses and arrived at Craik on the 27th, where we immediately pitched camp and with my whole party I was under canvas that night.

This small but thriving town of Craik, seventy-three miles north of Regina, is situated on the Prince Albert branch of the Canadian Pacific railway (now the Canadian Northern), and has a population of about three hundred, with many substantial buildings, including two large grain elevators, several churches, two hotels, numerous stores and two lumber yards; it is a distributing point for immigrants and land seekers who wish to look over, purchase or homestead land. It is the centre of a district extending easterly as far as Last Mountain lake (distant twenty-five miles) and westerly as far as South Saskatchewan river (distant from forty to fifty miles). At this point for those desiring to cross there is a ferry stationed at the Elbow. The land in the immediate vicinity of Craik is worth from twelve to twenty dollars per acre, an increase of one hundred per cent in the last two years.

The soil, although considered by some to be a trifle on the light side, yields excellent crops. I saw over one hundred acres of wheat adjoining the town, which, when threshed, yielded thirty-seven bushels to the acre, and this is only a fair sample of the produce yielded in the vicinity of the railway, where not so long ago the land was considered by many to be worthless.

The next two days we occupied in overhauling and repairing our outfit, purchasing and hauling supplies, etc., and on Tuesday, the 1st day of May, we pulled out of Craik, and travelling on a good trail as far as Walstad's ranch (distant eighteen miles) camped there for the night. During the next three days we continued our journey westerly, making about fifteen to twenty miles a day, following a good trail most of the way, which meandered through a beautiful rolling, open and undulating country, now rapidly being taken up by settlers of various nationalities. Along our entire route the work of the new settler was very much in evidence, that of ploughing and building predominating. Some convincing idea of the rapid progress of settlement in this district may be obtained when I state from experience that exactly a year ago one could travel on this same trail all day and not see more than one or two houses, whereas now from almost any part of it one can count as many as twenty buildings.

The settlers in this neighbourhood freight their lumber from either Craik, Mortlach or Caron, both of the latter are small and prosperous towns on the main line of the Canadian Pacific railway about thirty or forty miles to the south. The price of the lumber is thirty dollars per thousand.

Land in this vicinity is worth from seven to twelve dollars per acre, and is suited to the growth of wheat, oats, flax, barley, and vegetables, although to ensure bountiful crops considerable moisture is necessary as the soil is with little variation sandy loam.

On May 7, being at our initial point we commenced the resurvey of township 21, range 7, west of the third meridian and we finished the same on the 19th, being delayed a few days by rain. The surface of the northern and eastern part of this township is undulating and rolling. The southern part is broken and hilly comprising a portion of Vermilion hills. The western part is also broken and hilly, this being caused by the huge ravines and gullies which extend down to the banks of South Saskatchewan river which flows through the western part of the township. We continued work in this district until September 25, and covered an area of over seven hundred square miles.

During this time we resurveyed fourteen townships in all, including their outlines, a total mileage of six hundred and forty-two miles in four and one-half months, comprising townships 21, ranges 2, 3, 4, 5, 6, 7 and 8, townships 22, ranges 1, 2, 3, 4, 5 and 8 also township 23, range 3, all west of the third meridian.

By describing in detail the physical features of any of these townships, one is practically describing this section of the country. The surface in general is undulating to rolling except that portion adjoining South Saskatchewan river, which is rough and broken by numerous ravines and coulées extending down to the river. Generally speaking the soil throughout is sandy loam. Occasionally one finds a clay loam with a clay subsoil, and a little black loam is found in the bottom lands and in the dry beds of swamps and creeks. Contrary to general expectations this soil has proved exceptionally fertile; oats, wheat, flax and barley have been successfully raised. It is not unusual for such land to produce as much as seventy bushels of oats to the acre, or thirty-five bushels of wheat to the acre. These crops of course would be off land broken in the fall and would cost the farmer for threshing eight cents per bushel in the case of wheat and six cents per bushel for oats, the owner of the threshing machine furnishing all necessary help. It is usual to thresh about two thousand five hundred bushels a day, the waste straw supplying the necessary fuel for the engine. When a few additional machines are in this part of the country the above rate, it is presumed, will be reduced by one-half or thereabouts. However at present everyone is anxious to have his threshing done as soon as the grain is ripe, for at this season of the year, frost is not unknown. The consequence is that the number of machines being limited the demand is great and this accounts for the high rate per bushel. From the time of seeding to that of harvest, in the case of wheat, is from one hundred and five to one hundred and ten days, much depending upon the amount of rainfall and heat. Horses and cattle are obtainable from the Hitchcock-Ferguson ranch or from Walstad's ranch, both of which are in this section of the country. Horses cost about three hundred dollars per team and oxen about one hundred dollars per yoke ; a good cow costs from forty to fifty dollars ; wagons are worth seventy-five to eighty dollars, sleighs twenty-eight to thirty-two dollars and double harness twenty-seven to thirty-eight dollars a set.

Farm produce commands a high price: potatoes when procurable sell for one dollar to one dollar and fifty cents per bag, butter thirty to thirty-five cents per pound, milk seven cents per quart, eggs twenty to thirty-five cents per dozen, &c. Hay is rather scarce. but obtainable from Qu'Appelle valley and in a few of the large hay sloughs. In addition the settler cuts and uses the short prairie grass, commonly known as wool-top which is more nourishing than the hay taken from the sloughs and is generally preferred by stock. Hay usually sells at from eight to twelve dollars per ton, but it is not unusual to pay one cent per pound. The price varies according to locality and quality. A considerable amount of wheat straw is used by the farmer for his stock, in fact many cattle get little else during the entire winter and thrive very well, being in good condition in the spring.

Well beaten trails pass over all this section of the country, connecting with the nearest towns on the main line of the Canadian Pacific railway to the south and on the branch line of the Canadian Pacific railway to Prince Albert to the east. The Canadian Pacific railway are now constructing a branch line from Moosejaw to the Elbow and when finished it will not only increase the value of the land, but greatly facilitate transportation, which the country urgently needs to meet the requirements of the great influx of settlers.

Building material and supplies are procurable in the small towns at moderate prices and are freighted to the homesteads of the settlers by means of horses and oxen. For fuel, the settler burns coal, generally. This is obtainable at most of the railway stations on payment of seven to nine dollars per ton. A little wood is to be had from some of the coulées which extend down to Saskatchewan river, also some wood of small dimensions is obtainable from a belt of sand hills in townships 23 and 24, range 3. However this belt is being rapidly depleted to supply the needs of the settlers for both building and fencing purposes, and in a year or two, perhaps less, wood of any description will not apparently be procurable, except at the railway stations. In this connection it is unfortunate that there do not appear to be any indications of coal or lignite veins in this section of the country.

Good drinking water is rather hard to obtain in many places and until wells are extensively dug this will continue to be a slight detriment to this otherwise fertile portion of the province of Saskatchewan. There are very few sloughs or creeks in which the water is palatable, therefore wells are being dug, and water is usually obtained at a depth of from twenty-five to seventy-five feet, although in many instances the supply is limited and often alkaline. Owing to the unusually small fall of of snow and the limited quantity of rain for the past two years, most of the sloughs and many of the creeks shown on the maps as containing water have now little or none, for instance, Qu'Appelle river is entirely dry in many places.

As a rule, the soil in this section of the country is inclined to be light; it follows that a considerable amount of moisture is necessary to ensure good crops and vegetation. The system of 'boring' is now adopted by many of the settlers, and doubtless in a year or two good water will be plentiful. There are several excellent springs in the vicinity which have an apparently inexhaustible supply of pure fresh water, and naturally these are a great boon to the settler.

From personal experience while residing in this part of the country during the greater portion of the last two years, and from information obtained through old settlers, I should say that there are no summer frosts that are likely to do harm, although there may be an occasional hailstorm. On the other hand the heat during the summer months is intense. Vegetation usually commences about April 25 or May 1. At the end of April with the disappearance of the snow spring ploughing commences. May is an unsettled month, one day it may be 100 degrees in the shade, the next cold and raw, accompanied perhaps by a flurry of snow. Usually there is considerable rain during the months of May and June, and the next few months are dry and very hot, with an occasional thunderstorm. Last season we had, during the month of May, rain on fifteen different days, during June twelve days' rain, while during July and August the weather was very hot and a few thunder storms occurred. The first slight frost was noticed on August 25, but it did no injury to the crops. Throughout this section of the province (about seven hundred square miles) we did not perceive any indications of coal or veins of lignite, nor in fact minerals of any description.

On the tops of the numerous ridges boulders are more or less frequent, and doubtless, as has been done elsewhere, will be utilized by the settler for building purposes. I understand they make substantial, durable buildings, which give general satisfaction. Owing to the scarcity of lumber, many of the settlers build their houses out of sod. These sods are first ploughed in furrows, then cut into dimensions of 2½ feet x 14 inches x 3 inches, and laid on each other, similarly to the placing of bricks, and with the addition of a few supports on the inside make a very comfortable warm house or stable; if they are well made and lined with lumber on the inside they will last for years. Speaking in general terms of that portion of the province of Saskatchewan extending from Prince Albert in the north to Willowbunch in the south, from Melford in the east to Swift Current in the west, covering an approximate area of thirty thousand square miles, twenty-five thousand may readily be classed as excellent agricultural land; of this portion, where I have been engaged in surveying operations for the past two years, I may say, having travelled over it during that time more than once, that it is a beautiful extent of uninterrupted farming country, with vast unknown resources which one is unable to estimate with any degree of accuracy. It is being rapidly settled by a superior class of immigrants, many of whom might well be designated Canadian-Americans, men born in Canada who emigrated to the United States, lived there many years, married, became possessed of property, and being persuaded that they had now an excellent opportunity to improve their positions have sold out, returned to Canada, bought land and taken up homesteads in the great West.

When one contemplates the vast unknown possibilities of this country where as yet everything is new and in the experimental stage the future prospects are overwhelming and as a crude estimate, I venture to state that in the above defined limits, for every square mile now under cultivation, there are two hundred square miles of virgin soil. There is a considerable portion of this area which cannot rightly be designated strictly agricultural, but which is ideal for stock raising, more especially those portions adjoining Saskatchewan river, that portion comprising various ranges of sand hills, and a large area in southern Saskatchewan bordering on the Notukeu and Wiwa creeks and also on Wood river. This latter portion is a paradise for ranchers, and in it a number of ranches are now located, one of the largest of these being the 'Turkey Track Ranch,' situated about thirty-five miles southeast of Swift Current and possessing about sixty thousand head of stock. I passed through one enclosure in connection with this ranch, where there were four hundred Hereford bulls.

To a great extent the settler and rancher are dependent the one on the other, and views expressed by both to me were to a certain extent reciprocal, the two occupations being so closely allied.

It struck me that it might be advantageous (if possible) to set apart certain portions of the above mentioned lands for stock raising as most of it is entirely unfit for agricultural purposes and practically valueless to the farmer, while consisting as it does of broken hilly land, huge ravines, gullies and coulées it would afford excellent protection to the stock during cold weather. The original survey of the townships in this vicinity was fairly well executed, and with but few exceptions, the position of the original survey monuments were easily discernable, more especially to the practised eye. When these surveys were made in 1883, quarter section posts were not used in this neighbourhood (there being no wood to make posts) the only distinction between the mounds erected, was an iron tube placed at the section corners, upon which was placed a square tin with section numbers stamped thereon, these tins having in most instances disappeared, there was no distinguishing mark left to show a settler or prospector his exact locality. As a result much time was lost, it not being infrequent for a settler to squat on the wrong quarter section, and confusion naturally followed.

It is imperative that proper distinguishable marks be at all section corners at least and I respectfully recommend that all the townships surveyed in 1883 and 1884 be re-marked. I may say in connection with my season's surveys that I destroyed a number of old river lot mounds, and that the greatest number of miles surveyed in one day was fifteen. The weather during the whole season to November 15, was all that could be desired for surveying operations, and the trails were excellent.

On September 28 I left Craik to examine and, if possible, to correct some errors in the vicinity of Last Mountain lake, a beautiful sheet of water, fresh and pure, sixty miles long, and averaging two miles in width; it is also quite deep. Excellent fishing and shooting is afforded the lucky sportsman, who is fortunate enough to spend a few days on its delightful waters. I had the pleasure of hauling in a whitefish that weighed eight and one-half pounds; pickerel and jackfish are very numerous, and in fact quite a large fishing industry is carried on here. Also the many islands afford good breeding grounds for ducks and geese. The natural inference regarding this beautiful and attractive lake is that it forms an ideal summer resort, in fact, even now, on almost any day, numerous gasoline launches and smaller craft can be seen cruising on its clear waters.

After I had completed the work here satisfactorily, we moved to township 27, range 24, where I did some more correction work. It was here that I verified an error in the bearing of a meridian of 11° 46'—which had caused considerable dissatisfaction among the settlers, and upon which I duly submitted a detailed report to you. I then moved to township 29, range 26, and did some work there, afterwards returning to Craik, following a well beaten trail which led through a beautiful, open, undulating and well settled district. In every direction threshing operations were being conducted; I was informed that the average yield of wheat was twenty-three bushels to the acre. The farmers haul their grain from here in large wagons, specially made and containing one hundred bushels, to the elevators in Craik.

Arriving at Craik I completed some correction work in township 24, range 28, and then proceeded to township 19, range 29, and surveyed some meridian outlines and their connecting chords and also did some correction work. I then retraced both sides of the road allowance between townships 18 and 19, range 29, where a large error exists, also the meridian outlines adjoining the correction line, and forwarded you a detailed statement as to how matters might be rectified. The great trouble lies with the land already patented, and settlers who gain by an error in survey are very loath to agree to any change in the original survey monuments. On October 18 I left here for Swift Current to inspect certain contracts south of the town, where after a tedious journey through hilly country with few trails we arrived on the 23rd. While on this trip we passed through many small towns on the main line of the Canadian Pacific railway, and it is really astonishing to note the growth and progress made during the past year, besides the increased value of land and property.

At Swift Current where I remained a day the population has doubled during the past year, and property has increased in value amazingly; everybody appeared to be working, and apparently there was plenty of work for everyone. In all these towns and all through the west real estate appears to be the password. From Swift Current I travelled southeasterly to township 11, range 12, where I carried out your instructions, and on November 1 moved camp easterly about ninety miles to inspect certain contracts in that vicinity. My route lay along the valley of Notukeu creek, a fine stream of fresh water having an average width of fifty feet and quite deep, with fairly high banks. The country passed over is a continuous stretch of open prairie, with an occasional clump of willows on the banks of Notukeu creek. The surface is generally rolling, but quite hilly on the east side of Wood river which is a fine stream of fresh soft water and has considerable wood growing on its banks, suitable for fencing and firewood. In fact this is the only firewood in this section of the country which is unsurveyed and practically uninhabited, except by a few ranchers. The country is admirably adapted for ranching. The soil is sandy loam and no doubt as fertile as other sections of the country with the same kind of soil. We passed several large bodies of water, the largest being Johnston lake and the Lake of the Rivers, the water of which unfortunately is unpalatable. Hundreds of antelope were seen daily during our travels, occasionally jumping deer, large prairie wolves, foxes, coyotes, badger, also prairie chicken and countless thousands of duck, and geese of all varieties. One has to be an eyewitness to the flight of these wild fowl to the southward during the fall to even dimly conceive an estimate of their numbers or the vast quantity of food required by them.

On November 15 while in camp near the Lake of the Rivers, we were prevented from completing our work owing to an unexpected blizzard, which raged for four days and four nights, covering the ground with snow from three feet deep on the level, to twelve feet deep in the ravines, most effectually covering all fodder for horses and making wheeling almost impossible. As we were fifty miles from wood, and the weather extremely cold, I considered it not only advisable but compulsory to make the nearest town which was Moosejaw, distant about seventy miles. Owing to the unusual depth of snow, I was obliged to leave behind most of my outfit. Our journey to Moosejaw was trying, cold and most strenuous, as we had to break the trails for the horses which soon gave out as a result of being half the time down in the snow, which was always even with the wagon box. Having but little wood we felt the severe cold very much, as provisions could not be properly cooked, nor could we get thoroughly warmed, everything being frozen. We arrived at Moosejaw on the 23rd, both men and animals thoroughly exhausted, but thankful. Here we were told that this blizzard was unprecedented, and besides the loss of many cattle, several men were reported missing, in fact, subsequently, a man and his horse were found frozen to death within a few hundred yards of where we had passed.

After resting a few days, I hired two sleighs and sent back my men and horses for the remainder of my outfit. They, though better equipped and more prepared, had an exceedingly rough time, but brought in the outfit which we stored for the winter at Mr. A. W. Annable's ranch, Moosejaw.

Before closing my report, I desire to bring to your notice, the destruction of numerous mounds and pits by many settlers who, when ploughing, carelessly ignore the survey monuments and plough or harrow them over, thus filling the pits and obliterating the mounds. I suggest that some stringent method be adapted to prevent further destruction of these monuments, which the government is endeavouring to perpetuate for the settler's benefit, and which entail the expenditure of large sums of money. I also wish to point out that there is a great necessity for a properly conducted ferry to cross Saskatchewan river at a point in the vicinity of Log Valley. Considerable risk is run and much time is now lost in crossing, the traveller having to either swim his horses and ferry his wagons and belongings across with the best means at his disposal, or travel around by the Elbow, thus entailing an extra journey of from sixty to eighty miles.

During the past two years an epidemic of glanders has been prevalent throughout this section of the country, in fact so much so that the government sent veterinary surgeons to the various ranches to examine and report thereon, with the result that many horses were shot, and the disease was practically stamped out.

While in Moosejaw, I had the pleasure of being driven to and shown over and through the Moosejaw nursery, situated about a mile to the south of the town and located in a most beautifully sheltered spot, comprising about ninety acres. It is surrounded by high banks through which runs Moosejaw creek, utilized by the Company as a water supply and for irrigation purposes. Thousands of young trees of every description, and endless varieties of shrubs are kept for experiment and sale. Vegetables of all kinds are grown, and in the four large green houses (of the latest improved designs) flowers of every variety and green vegetables are always being cultivated. Although still in the experimental stage, the nursery has proved profitable beyond all expectations, and the supply being not nearly sufficient to meet the demand. I write the above as an illustration of what can be done in this country of surpises. as many people are under the impression that vegetables and flowers cannot be grown successfully during the winter months.

In conclusion, I wish to record my appreciation of the services rendered by my assistant, Mr. R. Oscar Spreckley.

I have the honour to be, sir,
Your obedient servant,

E. W. HUBBELL, *D.L.S.*

APPENDIX No. 26.

REPORT OF A. W. JOHNSON, D.L.S.

SURVEYS IN THE WESTERN PORTIONS OF THE RAILWAY BELT.

KAMLOOPS, B.C., February 5, 1907

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—Having sent instructions to some of the men to meet me at Lytton, I left Kamloops on February 19 for the Nicola.

My last year's aneroid elevations on the railway belt did not check out well, and I wanted to get a reliable height for my starting point on Spius creek. As a railway has been built up the Nicola valley since I was there, this was easily got, and I went on to Lytton, where Mr. Irwin, the Indian agent at Kamloops, was waiting for me. He wished to find the position of certain improvements near Indian reserve No. 27. Mr. McKenzie, agent of Dominion lands, of New Westminster, came up a day or two later, and he helped me with the final adjustment of lots 1460, 359, 1 and 2. The last two had been surveyed in the Caribou days, but all monuments were gone, and I had to survey them again, conforming as much as possible to the old notes and sketches. In my opinion it is a great mistake to use wooden posts at all, whether at quarter-section corners or any other. Even a cedar post will not last more than forty years though left absolutely undisturbed, and they will not stand much knocking about after twenty. I would also suggest that the iron posts supplied should be of better quality. Some of these I have had this year were so rotten that a man could break them with his hands. The ideal monument for British Columbia is a stout iron post and a pile of heavy stones.

Pits can be traced for perhaps ten years if they happen to be dug on the level and left quite undisturbed by stock, whereas a stone mound of regulation size, especially if made of large stones, is practically everlasting, and I have never seen one so much disturbed in this province, even by stock, that there was any difficulty in identifying it.

On the 27th most of the party went to Hope, while I went up the Fraser with one man to put iron posts in at some of the section corners near the railway belt limit, my supply having run out during the previous fall. This took a couple of days, and we then followed to Hope.

In 1902, I made a preliminary survey of this townsite, and left iron piping at some of the main street intersections. The place was surveyed originally in 1861 by the sappers and miners who built the Caribou road, and wooden posts were put in. Nobody knew of the existence of any of these original marks, and though I worked for months in the townsite it was not until the survey was almost complete that I succeeded in finding one. It tallied very closely indeed with my own work, which was based on old fence lines and such old buildings as were reported to stand on lot lines. As there are two or three people in Hope who have been in the town since 1860, I was able to get fairly good evidence, though no really authentic starting points. The Hudson's Bay company once cleared practically the whole townsite to grow feed for their pack trains, but it has been allowed to grow up again, and is now covered with dense bush except where the few houses are.

It is patiently waiting for a railway, with the advent of which a tourist traffic is certain to spring up, for a pleasanter spot for a summer holiday could not well be found. There is splendid trout fishing close to the village, mountain climbing 'ad nauseam,' and big game shooting for those who like to take the risk of climbing round giddy corners after goat, or the trouble of forcing their way through the interminable vine maple and huckleberry brush to the high open slides, every one of which is the feeding ground and exclusive property of some bear.

Besides making the resurvey of the townsite itself, I put monuments in at several of the corners of surrounding lots, and as far as possible made the survey between Hope and Silver creek rigid. I have spent a great deal of time in and near Hope, and have had the invaluable assistance of Mr. McKenzie in every way he could afford it, and I feel convinced that with the proper data available, and bearing in mind that all landowners who have seen the survey are satisfied, it would be a waste of time and money to go over the work again.

On April 16, we went down to Sumas lake by canoe. While here I made a correction in my resurveys of lots 225 and 226, and as soon as possible returned to Hope, picking up a few horses on the way. I also sent to Nicola for ten horses by a man who was buying some there for himself, and began a traverse of the Similkameen trail before they arrived. On the way up this trail we ran a couple of section lines at what is known as Lake House, or Beaver Lake, and after reaching the limit of the railway belt ran along it as far as my last post in 1905. My tie came out exceedingly well to all appearances, but I found afterwards that there were two mistakes, equal and with opposite signs that neutralized each other, one on the traverse up the Similkameen trail, the other somewhere on the railway belt limit of last year. Therefore in September I came back and re-ran this part of the limit. From the Similkameen trail southward the belt limit takes to the mountains in earnest. The first half mile leads up a two thousand feet precipice, and when we moved camp the only possible place to get up the mountain was two or three miles down Skagit river. We camped three thousand feet above the valley, arriving in small and very much scattered detachments, with in many cases much smaller packs than were gaily strapped on in the last camp. As tents were among the things thrown away, it was unfortunate that it should rain that night, and there were some very unhappy men around the bacon and beans next morning.

The mountains are so precipitous here that I had to do a good deal of triangulating. Up to a height of five thousand feet above the sea they are covered with dense balsam forests, but the wood is soft and full of knots. Up to six thousand feet there may be odd clumps of dwarf balsam or juniper bushes, but I think that six thousand five hundred may be considered extreme timber line. There is practically nothing after six thousand.

The railway belt limit keeps very high, in fact, runs over the top of Marmot mountain nearly seven thousand one hundred feet high. It goes down into thick balsam again along the north boundary of township 2, which is parallel to Marmot creek, and then gradually works up on to Silvertip mountain, which is the highest and most imposing mountain north of the international boundary in this district. According to my aneroid, checked by vertical angles read by transit on other known elevations, it is eight thousand seven hundred feet above the sea. The north side is inaccessible and two small glaciers are perched in the only place level enough to stay on. When I say inaccessible I mean from the ordinary human being's standpoint, not from that of a full-fledged member of the Canadian Alpine Club. I have tried it from that side with an Indian, who had a marvellous head for heights. We persevered until we found ourselves sitting on a knife edge with nothing at all on three sides of us. As far as we could see nothing but a balloon would take us up to the top. When you come to think of it an air-ship is the solution of the surveying problem in British Columbia. You could work for miles round one permanent camp and above all things there would be no packing. The south slope of the mountain is comparatively easy, and the view from the top, magnificient, but you wonder where the land is. For a hundred miles in all directions there seems to be nothing but rock and ice. The slides below the glaciers are very steep and covered with dense vine maple and cypress so dense that it was very difficult indeed to force your way through with a pack. We took our bundles straight across one of these slides and tackled the opposite ridge. Unfortunately we struck it at a very bad place and the brush was so thick that we could not see anything ahead. This was the worst pack I have ever had. The climb itself was insignificant, some eighteen hundred feet or so, but with sixty pounds on your back you have difficulty in negotiating corners that are comparatively easy when travelling light. Twice we had to unload, climb into positions over one another's heads and with infinite care pass the packs up from man to man. Most of us did at last get up, but two of the stragglers did not turn up till night, and one man only got in next morning. Naturally enough he was the cook. When we got off Silvertip we were in the valley of Klesilkwa, which is separated from Silver creek valley by a low pass, about two thousand feet above sea level. I took the belt limit across this valley and ran parallel again for three miles along a mountain composed of solid granite. There are two miles of old rock slides with huge granite boulders, from the size of one's head to that of a house, requiring only a little dynamite to furnish the finest building stone I have ever seen. There are hundreds of thousands of tons of it that do not even require quarrying.

The Klesilkwa side of the pass is level and very swampy. It averages half a mile in width and there is land enough for some settlement when the timber has been taken out. This is mainly cedar and hemlock.

On the Silver creek side of the divide the valley narrows down and is not more than a quarter of a mile wide in most places. There is fir here besides cedar and hemlock, but not much land.

I ran a series of section lines down this valley as far as Silver lake, and connected with Hope by triangles over Hope mountain. I made this survey because there was an application for land at the south end of Silver lake, for the purpose of raising cattle. I do not think I have seen anywhere in the world a more unsuitable or hopeless place for raising cattle in. Dense crab apple and willow thickets grow immediately around the lake at its south end, alder and cottonwood along the creek, and the rest of the valley is covered with the densest growth of cedar, fir and hemlock. There is not a stalk of natural food and no range on the mountains which are precipitous, and only suitable for mountain goat.

When I tied on to Hope I found a mistake which was located during the following week, and I left Mr. Weld with a small party to make necessary corrections. I should not like to send this report in without saying that Mr. Weld was a very great help to me this year. We had a difficult party to handle, and the position of assistant is not at all a pleasant one. In spite of these facts he finished the corrections on time, and I doubt whether many men under the same circumstances would have finished them at all. While these corrections were being made I took the rest of the party and worked over the two ranges separating Klesilkwa creek from Chilliwak lake.

The first of these ridges is slightly over seven thousand feet and the second not much more than six thousand. Both of them were covered with huckleberries and blueberries and as a result bears were very numerous, especially as the above berries are a failure in other parts of the province. These bears were a real hindrance to the work, for the Indians would not go away alone without a rifle, and in one case refused to cross a valley at all. I laughed at them for a long time and occasionally went ahead myself to show them that their fears were groundless. However, one night while coming down a mountain side to supper with one of the Indians, we ran across a big bald-faced she-bear and cub. They were directly in our way, so I shouted to scare them off. It did not have the desired effect at all for the old bear immediately turned and charged. I think we both had pocket knives, but they did not seem very comforting so we fled. She may not have come very far, we did not stop to see, but she did not catch us. I think it is better to let bald-faces and grizzlies severely alone if you are unarmed.

There are goats on the highest ridges and plenty of marmots or whistlers as they are called here. The Indians call them the whistle pig.

The descent into Chilliwak lake was down very steep smooth rock at first, so steep that it was out of the question to put the section corner in.

We joined the pack train on the lake at Depot creek on August 11. The packers had just finished building a canoe for our use while there. Here also was a party working on the international boundary. For a week I worked from this camp, and then packed clear to the top of the ridge on the west side of the lake.

The belt limit went over some very bad country west of the lake before reaching the first ridge, country comprising ravines, rocks, precipices and, slowest of all, 35° slopes covered with dense balsam. Once out of the timber I put most of the work in by triangulation, because most of it lay over inaccessible rock.

On August 24 I got down to the international boundary, and measured westwards by means of triangles. The bases were exceedingly short, but I took great care with the angles and on the 28th tied on to a post I set four years ago.

There was little or no game on the ranges west of Chilliwak lake. There appeared to be no feed. There is no agricultural land between Silver creek and the international boundary, except a little on Chilliwak river and at the south end of the lake. A little good cedar and fir may be found around the lake, but the great bulk of the timber is knotty balsam, which as far as I know is no good for anything but firewood and second rate pulp.

Minerals are worked to some extent both in Slesse creek and Middle creek and rumours are heard from time to time of big veins between Skagit river and Chilliwak lake. It is probable that at no very distant date the lake will be a summer resort. The fishing is very good, the scenery of course gorgeous and there is nearly always a sailing breeze.

It would be easy to build a good wagon road up to the lake which then could easily be reached in a day from the town of Chilliwak.

On September 10 we began work on the correction of the railway belt limit from the northeast corner of section 13, township 3, range 23, to the last post I put in last season. It rained a great deal while we were here and the country was very rough indeed, so rough that we had some very uncomfortable moments chaining. A mile on a map looks such a short distance and so easy to chain that people who have not scrambled painfully up a rock with a chain tied to their belt with a long hard drop coming if they let go cannot realize what an enormous distance a mile sometimes is on the ground.

From Hope I sent two men back to Kamloops with the twenty horses that comprised the pack-train. They will do better in the upper country than at Sumas where they were last winter. At least they cannot possibly come out thinner in the spring. I was fortunate in my two packers. I doubt whether they could be beaten in British Columbia. One of them I left in charge of the base all summer. It was his duty to see that everything I needed was moved forward into valleys that the belt limit crossed. This left me at liberty to push the flying camp forward on line, because I was always morally certain that when I dropped down for supplies I should find him in the desired spot.

Before leaving this district I ran the boundaries of lots 5 and 6, near Hope, which were in doubt, and on the 22nd moved down to Agassiz by canoe. After a couple of days work in section 28, township 3, range 28 I got word that some work at Sumas was very urgent and I moved down at once by canoe to the south end of Sumas lake in township 19, east of the coast meridian. Nearly all the land around this lake was surveyed thirty or more years ago, and as it is covered every year by water, the old monuments have in most cases disappeared long ago, so that it is extremely difficult to do anything with it, but I think that what few corners I did re-establish are as near their original positions as is possible to put them now. While here I did some work of the same nature on the upper Sumas Indian reserve and on lot 227, group 2. I also made a small traverse in section 13, township 20, east of coast meridian.

On October 11, I went up to Lytton with Mr. Weld and one man. We did a few days work here on lots 1 and 2 and in section 35, township 14, range 27, west of the coast meridian and then I took a couple of weeks holidays, partly for my own ends (I wanted a grizzly and got one) and partly to get some idea of how to tackle the country between Harrison lake and the Fraser, where I shall be next season.

On November 6 I went down to Agassiz again and next day continued the work on islands in the Fraser that I had left when asked to go to Sumas. Besides this there was a good deal to do around the village itself on lots 49, 19, 10, &c. In this I had the assistance for a day or two of Mr. McKenzie, who knows a great deal more about the land in the New Westminster district than anybody else and we were able to do a good deal of resurvey work. I tried to find posts in section 5, township 4, range 28 up Maria slough, but was unsuccessful, so I wrote for the old field notes and paid the men off for the season, getting back to Kamloops on December 4.

The season has been in many ways remarkable. While at Hope, in March and April, the weather was glorious, which is unusual at this time of year. May and June were wet, but July, August and the first part of September were finer than anything I have seen in this district. Had it been otherwise the work would have been much more unpleasant even than it was. We seldom used tents, but slept out under the stars, and the fine weather enabled us to carry fewer clothes than usual, which is a great point when packing. If I had not had a nucleus of men who had been with me for years and who did not like to see me left in a hole, I should probably have finished the work with Mr. Weld and a party of two. As it was we left Hope seventeen strong and came off the international boundary with nine. Some had cut themselves, some were ill, but most were sick of packing. We had three months mountain packing with little intermission, moving camp on an average three times a week, and men will not do it if anything else at all is to be had. It did not improve matters when we got down to the south end of Chilliwak lake and found men on the point of leaving the boundary survey because there had been no fresh vegetables for three whole days. We had potatoes twice in three months.

The fall was wetter even than that of last year, which is saying a great deal, and we had several days when it was out of the question to do any work at all.

I have the honour to be, sir,

Your obedient servant,

ALFRED W. JOHNSON, *D.L.S.*

APPENDIX No. 27.

REPORT OF J. A. KIRK, D.L.S.

SURVEY OF PART OF THE NORTH BOUNDARY OF THE RAILWAY BELT IN BRITISH COLUMBIA.

REVELSTOKE, B.C., March 14, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour in accordance with my instructions, to submit the following report of my survey to establish the north boundary of the railway belt at Blaeberry creek in the province of British Columbia.

The survey consisted of two traverse lines run from the northeast corner of section 20, township 28, range 22, west of the fifth meridian up the valley of Blaeberry creek to the objective point, a distance approximately of twenty-five miles. My report may therefore be appropriately styled 'A report on that part of the valley of Blaeberry creek within the railway belt.'

Blaeberry creek rises in a large glacial area, crowning the divide of the Rocky mountains at about 117 degrees of west longitude. It flows southerly for about twelve miles and enters the railway belt at the north boundary of section 10, in township 31, range 20, west of the fifth meridian. It continues southerly and southwesterly through ranges 20, 21 and 22 to its confluence with Columbia river in section 30, township 28, range 22, a distance of between twenty-six and twenty-seven miles.

The west side of the valley is paralleled by a range of mountains that rise in lofty and picturesque peaks, broken only by the narrow valley of a stream which rises in the glacial fields on the divide and flows southwesterly to its junction with Blaeberry creek at a point about three-quarters of a mile south of the boundary of the railway belt. As this stream materially increases the volume of the Blaeberry, it may appropriately be designated the 'west fork.'

On the east side a ridge runs parallel to Blaeberry creek from the north boundary of the Belt, southerly for about six miles. The flanks of three ridges bearing southeasterly constitute the east side of the valley between this point and the valley of the Columbia. The streams flowing through the three valleys thus formed comprise the tributaries of Blaeberry creek from the east. The middle one I have named the 'east fork,' as it is larger than the other two together, and contributes to the main stream nearly if not as much water as the 'west fork.' The disclouration of the water in the summer shows that the 'east fork' and the stream to the south of it are fed by glaciers.

Several small streams rise on the faces of the mountains on either side of the valley and from springs along the bordering flats, and these in many cases disappear by sinking under the surface. The valley is naturally divided as to its physical features into three parts, which for convenience of reference, I have named the upper section or gravel flats, the central or rocky section, and the lower or bench land section. My description will begin with the central or rocky section.

Central or Rocky Section.

A series of ridges which cross the valley and unite the mountains on either side, extend southerly for about five miles from a point about a quarter of a mile above the mouth of the 'east fork.' Through these ridges, which consist of a species of soap stone soft enough to be scratched by a finger nail, the creek has cut a channel from fifteen to seventy-five feet in width. In places the vertical walls of the canyon thus formed are over a hundred feet in height. Through this section the creek is a succession of rapids, as the total fall is probably not less than two hundred and fifty feet. Further reference to this section is made in the paragraph following the description of the upper section.

Upper Section.

Proceeding up stream from the canyons, the bottom of the valley is a gravel flat, on which, speaking generally, there is a light covering of soil that increases in places to several feet in depth. It seems evident that the rock at the entrance to the canyons has not been cut out as low as the grade of the rock forming the true bottom of the valley above, and that the dam thus formed holds the gravel forming the flats as in a basin. The creek meanders with a swift but uniform current in a channel that is constantly shifting during times of high water. An expanse of gravel bars has thus been formed that is constantly increasing in width by the erosion of the banks.

The valley averages about half a mile in width. The mountains forming its bounds have the usual features of the Rocky mountains. The summits are destitute of vegetation, and often rise in sharp ridges and peaks of fantastic outline. The faces of the hills are frequently a succession of slides, while the slopes at their bases are composed of sharp-edged rocks that have fallen from higher levels. These slopes are usually covered with soil. The soil on the west side generally reaches higher levels and is of better quality and greater depth than on the east side.

The country is covered with a growth of spruce, cedar, fir, hemlock and pine, spruce predominating. On the lower levels of the mountains and on the flats along the shore of the creek, there are belts of timber that will run from twelve to twenty-four inches in diameter at the butt end. The cedar is usually hollow and not large enough to have sufficient sound wood to make it valuable. The other woods are generally of good quality, but as is common in this section of the country, the trees contain but a small percentage of high-grade or clear lumber. I estimate that there is between three and four square miles carrying from twenty-eight to thirty million feet log scale of mechantable timber in this section. In addition to the timber described, the country is covered with a smaller growth admirably adapted for pulp wood.

This section is remarkable for the absence of traces of forest fires. If my conclusions are correct, this is due to the following causes. During the summer months, while the country in the vicinity of Golden is parched for want of rain, storm clouds are often seen approaching from the west which turn to the left at Mount Moberly and continue up the valley of Blaeberry creek. Along the upper reaches of the creek these clouds precipitate their moisture. This phenomenon probably prevails during the winter when the precipitation augments the glaciers in which the creek rises. The greater portion of the rain falling on the rocky surface of the summits unwatered by the Blaeberry, does not form into creeks, but descends rapidly to the debris at the base and percolates through the soil, thus keeping it constantly moist, while the flats bordering the creek, while not swampy, as a rule are full of springs from the same source. This feature is an important point in connection with the area I am now describing as it appears to thoroughly protect the forest from fire. It is true that burnt trees are to be seen high up on the mountain side that have grown on small ledges of rock, but this fact accentuates my point, as in such places the moisture rapidly drains off.

Central or Rocky Section—(Continued).

In the section cut by canyons the gravel flats are replaced by bench land through which ridges of rock protrude. The country has been overrun by fire and only isolated patches of a large forest remain. The precipitation decreases as the Columbia valley is approached, while the drainage from the mountains and local rainfall, sinks rapidly through the porous, sandy and gravelly soils of the bench lands, leaving the surface dry, and in a favourable condition for the spread of fire. Young forests of pine, spruce, &c., are covering the brulé.

The trees are small yet, but in time if protected they will have a commercial value. There remains near the southern part of this section about a third of a square mile of fine spruce, balsam, &c., estimated to contain about five million feet, log scale. Along the banks of the east fork there is a fine body of spruce and balsam, but I had no opportunity to go through it.

APPENDIX No. 28.

From the foot of the canyons the stream flows in a channel from seventy-five to a hundred feet wide, for about a mile and a half. From this point to a small canyon near the railway it meanders through gravel bars similar to those described on the upper reaches of the creek. Emerging from the canyon, which is almost a quarter of a mile long, the creek crosses the flats of the Columbia and soon forms part of that river. In this section the valley widens. Bench lands that have been overrun by fire, and on which a new forest is appearing, are its principal features, until it merges into the valley of the Columbia.

Respecting the valley of the Columbia, I would refer to my report on the survey of sections 1, 2 and 3 in township 28, range 22, west of the fifth meridian, particularly to the part reading as follows:—

I have been told that this land is part of a timber reserve, and therefore not open for settlement. There is no timber here, and apparently never will be, as the new growth is confined to willow and poplar. If it is supposed that by keeping the place in a natural state an efficient fire break is provided between the railway and the country to the north, I would point out that the dead timber now strewn over the ground is very inflammable and a source of danger, while a cultivated field cannot be surpassed for checking the spread of fire. I would therefore take the liberty of suggesting that if this land is in a timber reserve, that the reserve should be withdrawn from that part that may be called the valley of the Columbia.

A wagon road from the town of Golden runs northwesterly alongside of the Canadian Pacific railway through Moberly, a flag station, to Blaeberry creek. This road is kept in repair by the provincial government. From this point a good trail runs along the east side of the creek for about eighteen miles. The gravel bars of the river afford good travelling for points farther north.

The soil throughout the valley is of a sandy and gravelly nature. The prevalence of summer frosts and late springs make its use, for general agricultural purposes, out of the question. Hay could doubtless be grown, but there are no wild hay lands. Feed for horses when travelling is not plentiful.

During the summer months the volume of water in Blaeberry creek is large. In the winter it is said to dwindle to insignificant proportions. The water during the time of high water is heavily charged with silt. The fall in the canyons is sufficient for the development of a large amount of power. The problem of bringing logs down the shifting channels that have been described seems difficult. My opinion is that a dam could be thrown across the creek at the entrance to the upper canyon, that would submerge the gravel bars and permit of the transportation of logs in safety. The extent of country that would be flooded and the damage that might be done would have to be considered when deciding on the height to which the water would be raised. A dam at the canyon near the railway would cover the bars on the lower reaches. As the banks are high in this section, it is probable that raising the level of the water would not affect the adjoining country. Wood is always available for fuel.

No indications of coal or lignite were seen. North of the east fork a mile or two, the mountains on the east side of the valley are strongly coloured with iron; with this exception no indications of minerals were seen.

Bears and goats are plentiful. This valley is of no apparent value except for its timber and pulpwood resources. The upper reaches are the most valuable in this respect. The poor and shallow soil is not conducive to timber of large size. The ground seems unable to provide sufficient nutriment for trees after they attain a certain size. Hence the cedar is usually hollow, and large healthy trees of any kind are rare. Still the valley produces fair timber, that with proper protection will remain a permanent asset to the country.

I have the honour to be, sir,
Your obedient servant,
J. A. KIRK, *D.L.S.*

APPENDIX No. 28.

REPORT OF G. J. LONERGAN, D.L.S.

RESURVEYS AND INSPECTION OF CONTRACTS IN CENTRAL ALBERTA.

BUCKINGHAM, QUE., February 4, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I beg to submit the following general report, concerning my survey operations during the past season.

In accordance with your instructions, dated April 1, 1906, authorizing me to continue the restoration surveys in Edmonton district, I started from home for Edmonton on April 23, where by previous arrangement, I had my transport outfit to meet me, and after engaging the men required for the summer's work and purchasing two months' supply of provisions, I started from Edmonton on May 3, for township 56, range 24, west of the fourth meridian. I travelled by way of St. Albert and Morinville, and thence east to the south boundary of the township. From Edmonton to Morinville, there is a good graded road, and as far as we could see on either side every acre is under cultivation. The soil is a good sandy loam, and for its productiveness, I had only to look at the farmers' buildings and dwellings.

Morinville at the time of my arrival, was soon to boast of a railroad and station. The Canadian Northern railway had their grade built that far last December, and expected to have the steel laid by the end of June. Township 56, range 24, is suitable for mixed farming. The southeast portion is thickly settled, and about three-quarters of it is under cultivation. The remainder was heavily timbered, but the recent fires have killed most of the trees and it is now nothing but a mass of windfall and brulé.

The Alberta government is helping to build a road through the township two miles from the east outline. This will give the settlers from Legal a more direct route to Edmonton, and will help to open out that northern country.

My next move was to townships 59 and 58, range 22. To get there I crossed Sturgeon river, one mile north of Namao, and thence east along the correction line to Fort Saskatchewan. I then went northeast along the Victoria trail about 20 miles until I came to a small Galician settlement. All this country is thickly settled, the occupation being mixed farming, and considerable attention is devoted to hog raising. In conversation with many of the settlers, I learned that the great drawback is the lack of a continual market for hogs.

No doubt there is a great opening for a firm to establish a large pork-packing industry. There is at present a small plant, but they are not able to even handle the supply of pigs that the farmers have, nor are they even able to supply the Edmonton consumption with bacon and ham. The result is that the merchants have to import meat, and the citizens have to pay from two to three cents more per pound. In short, the supply of raw material is there, the consumer is there, but the manufacturer is unfortunately absent.

On my arrival at these townships in which I had a few corrections to make, I found but four or five settlers. They had come that spring, and were busily engaged in making preparations to put up hay, their intention being ranching exclusively. Without a doubt they had chosen a good district, and will make a success of cattle raising, as long as they are not troubled by others who want to grow crops.

Vermilion river passes through township 58, and the valley has an average width of about a mile and a half, where an almost unlimited amount of hay can be cut. To the north there are many large sloughs, with about a quarter to half a mile border of good hay land.

Game is plentiful. I was there but two days, and saw a number of tracks of moose and elk. One of the settlers killed a large black bear, which had four cubs which he caught alive, two black, one brown, and a white one. Along the river bank, mink, marten, fisher, lynx are found, and in one place I saw where beavers were at work, building a dam.

My next move was to townships 54, ranges 20 and 19, to retrace the outlines of Elk park. The government is certainly to be congratulated in making this park reserve. The land is high up in Beaverhills, and is useless for farming, it being only rolling sand hills, and as the elk had already chosen it for their homes, it was but right that the government should perpetuate their choice by fencing them in and leaving them there to multiply.

By wire I was instructed to resurvey townships 51, ranges 2 and 3, west of the fifth meridian; so on July 3, I left Edmonton, going by way of Stony plain.

I would here like to correct the mistaken idea a number of people have that Stony plain is a rough rocky place, as the name would indicate. In fact I never saw a stone in the district; it is level, the soil is a rich sandy loam, and it is known to be the place where the best number one hard wheat is grown in Edmonton district. The place was formerly part of a reservation for a tribe of Indians, known as the Stony Indians, and hence its name.

The Canadian Northern railway have their grade built to within a mile of the post office, and they intend to lay the steel in time to move the fall crop.

All the land was taken up in township 51, range 2, and about one-third of township 51, range 3. The soil in most places is a sandy loam, and the surface is very rolling and covered with windfalls and brulé, and cut through by Saskatchewan river, which has in most places high perpendicular banks.

While working west of Edmonton, I came in contact with a number of the settlers, and in conversation with them as to the way they disposed of their grain, they said that a very satisfactory plan, was for a number of them to club together and load a car, and ship direct to commission merchants at Winnipeg, who would either store it in elevators or sell according to orders from the shipper, and that they had at times realised as much as six cents per bushel more than the Edmonton market, and never less than one cent higher.

Having completed the survey of these two townships, I received instructions to discharge half of my party, and to do sundry other scattered surveys. I returned to Edmonton on August 28, and made preparations for a move to township 52, range 12, west of the fouth meridian. The road that I followed was by Fort Saskatchewan and Star, thence southeast on Beaverhills lake trail to Vegreville.

The way in which the country is settling up, was a great surprise to me, for four years ago, there was not a dozen settlers, while to-day the trails are mostly all fenced and the settlers have put up good substantial dwellings and outbuildings, and I did not meet one settler, who was not perfectly satisfied with the country. Around every house they had vegetable gardens and were growing cabbages, onions, cauliflowers, carrots, parsnips, rhubarb, cucumbers, tomatoes, &c., and in many places sweet corn.

One farmer had started a fruit garden and said there was no doubt about the possibility of growing strawberries, raspberries, gooseberries, currants and other small fruits.

On my arrival at the township, I found but four settlers, who had taken up land in the southwest corner, and as they had been there but a short time they had but few improvements made. The territory generally speaking is rolling, with sloughs and ponds in the hollows.

During the hunting season a sportsman would realize his most extravagant dreams of hunting ducks, geese, swans and pelicans which are there by millions.

I next started for township 56, range 3, west of the fourth meridian. I travelled by way of Dinwoodie to St. Paul's crossing of Saskatchewan river, and thence to St. Paul de Metis. There are not a great number of settlers along this road and those who are there are ranching, doing very little mixed farming. St. Paul is the home of the half-breeds. The missiion is situated on the north side of lake Therien, and was started eight years ago by the Rev. Father Therien. After much privation and hard work, they have succeeded in changing a scrub country into a profitable farm and beautiful garden, built a large church, a school and a convent. Although the latter was burned down a few years ago, they are now rebuilding it. The garden is a model of neatness, growing all kinds of vegetables; their pumpkins, cucumbers, celery and tomatoes, would rank with the best I have ever seen in the east. They had a large crop of oats, barley and wheat; the latter would grade No. 1 northern. The mission has a steam thresher, sawmills, shingle mill, flour mill, crusher, together with a full complement of other farming machinery.

From St. Paul I travelled eastward along the old Battleford trail as far as Onion lake. Although the land is subdivided, there are but few settlers. The soil is generally good, but in a few places it is light and sandy.

Mr. Walker, the member for Victoria, told me that it was the intention of the provincial government to operate a ferry across Saskatchewan river some place between Moose and Dog creeks. This would give the settlers railway communication not more than thirty-five miles distant.

However, it will be a matter of only a few years when a railway will be built on the north side of the river ; for at the present rate of immigration, such a large tract of good country cannot lie long in wait for railway facilities, and I heard it reported on good authority, that there would be a road in there before three years.

From Onion lake I drove south to Lloydminster. From the river to Big gully, there are no settlers. At Lloydminster I inquired from the land guide, why such a large tract of good land was not settled. He said it was impossible to locate a corner, as there was hardly a mound to be found and no posts, the result is that the land must remain idle until resurveyed. I completed the work near Lloydminster, and then returned to St. Paul, where I examined contract No. 23 comprising townships 59 and 60, ranges 7, 8, 9 and 10. The centre three-quarters of these eight townships can be classified with the best soil in the province of Alberta; at present it is uncultivated and unsettled.

I then returned to Edmonton, arriving on November 17, and as the ground was covered with about a foot of snow I bought three sleighs and started for township 51, range 22, west of the fourth meridian. This township was originally part of a timber reserve, but of late years the repeated fires have destroyed most of the timber.

I did not have time to travel over the reservation, so I made inquiries from the settlers. Mr. J. W. Morton, Tofield, Alta., informed me that the west half of townshop 52, range 19, has about sufficient timber for the requirements of settlers. Mr. H. K. Adams of the same place says that township 51, range 19, has no timber, save a few clumps of scattered poplar, and that there are some sections of good farm land which has not a tree greater than six inches in diameter. Mr. S. Adams, of Edmonton, says that township 52, range 20, has not more timber than will be required for building purposes for settlers. From what I have seen of the country, I think that the views of these gentlemen are about correct.

Township 51, range 20, west of the fourth meridian which I subdivided, has no timber; the surface is rolling with numerous ponds and sloughs, and the soil is a sandy loam.

The Grand Trunk Pacific railway crosses the north half of the township, and it is expected that Cooking Lake station will be at the northeast end of the lake. Having completed the survey, I returned to Edmonton, where I discharged the men, stored the outfit and returned east, and arrived at Ottawa on December 23.

I have the honour to be, sir,
Your obedient servant,
G. J. LONERGAN, *D.L.S.*

APPENDIX No. 29.

REPORT OF J. W. McLAGGAN, Esq.

EXPLORATORY SURVEY IN SASKATCHEWAN AND KEEWATIN.

STRATHCONA, ALTA., November 1, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I left Strathcona on July 28, and reached Prince Albert on July 30, where I succeeded in securing a small Peterborough canoe at a cost of $55. I could not get one large enough to carry provisions sufficient for the trip. I left Prince Albert on August 2 with August Krosse, my assistant, whose salary was $60 per month. We reached Cumberland House on the forenoon of August 8. We had to get an Indian to guide us across the lake at a cost of $5 for the trip. I could not get a large Peterborough canoe here, so bought a bark canoe from an Indian for $13 which, with the one we had, was sufficient to carry our load.

I found that a guide could not be secured here and was told by the Hudson's Bay manager that one could likely be secured at Sturgeon river, north of Cumberland lake, I decided to cross the lake in the afternoon of August 9 in a small tug working for the Hudson's Bay company. We reached Sturgeon river late at night, and next morning I found that no guide could be secured there, so I decided to return to Cumberland and to go from there to The Pas, where a guide might be obtained. We reached The Pas on Wednesday, August 15, where no guide could be induced to leave until after receiving the treaty money, so we were compelled to wait until Wednesday, August 22, when we started off.

The weather had been very good this far on the trip and the gardens looked well at Cumberland and The Pas. Cucumbers, beans, corn and other garden produce were growing well.

I secured Pierre Highway, an Indian, as guide at $2.50 per day and free tobacco. I had difficulty in getting a guide even at that figure.

(NOTE.—The report covering the period from August 22 to October 23 is taken from Mr. McLaggan's diary.)

Wednesday, August 22.—Started from The Pas in afternoon with outfit as follows: two canoes, tents, blankets, cooking outfit, rifle, shot gun, ammunition, fish net, pair climbing irons, field glass, magnifying glass and compass.

Used climbing irons and field glass in cruising country for timber, climbing high trees on hilltops and using field glass where a good view of surrounding country could be obtained.

Reached portage on evening of first day, having travelled 15 miles.

Thursday, August 23.—Made a portage of three miles and camped on Atikameg lake. The country is low and swampy, timber poor and land of poor quality; signs of moose; weather fine.

Friday, August 24.—Made fair run and camped at narrows on Atikameg lake. This is a beautiful lake with small mixed timber of poor quality along shores. Shores are rocky and composed of limestone. The country is level, and the land poor and rocky. Fish, such as trout, whitefish, jackfish and pike, are plentiful. Small fruits, such as gooseberries, raspberries, cranberries, black currants and red currants, are also plentiful. There is no sign of frost.

Saturday, August 25.—Went five miles on Atikameg lake and made two portages into Cormorant lake. Then went five miles on Cormorant lake and camped. The land is poor, timber small and of poor quality. Fish and game are plentiful. A great deal of this country is level and rocky, of limestone formation. Banks of lake about twenty feet above high water. This deposit of limestone may be of great value in time.

Sunday, August 26.—Weather fine, with high wind.

Monday, August 27.—Crossed Cormorant lake, and camped near upper end of Yawningstone lake. There was good spruce timber on north side of Cormorant lake, and along creek between Cormorant lake and Yawningstone lake, and also on south side of Yawningstone lake. This timber is of good milling quality, and would say there is from three to five million feet at this place.

Land north of Cormorant lake is good clay loam, where farming on small scale could be carried on successfully after timber was cleared away. A garden at George Cowan's, near Cormorant lake, looks very well. Potatoes, carrots, onions, turnips and cabbage doing well, with no signs of frost. Saw no signs of minerals on Yawningstone lake. Weather fine.

Tuesday, August 28.—Crossed Yawningstone lake in the morning, and had hard day on Cowan river, low water and driftwood in the stream giving us a great deal of hard work. Country low and flat, with some good spruce timber in spots, but only in small quantities. The greater part of the country seems to have been burned some years ago. Land is a clay loam mixed with sand, and is only fair for farming purposes. Signs of moose and bear very plentiful. Camped about one-half way up Cowan river. Weather fine.

Wednesday, August 29.—Find it slow travelling on this river. Camped about three miles below Black Duck lake. Country low and swampy, with some bunches of good spruce timber on west side of river, about four miles below Black Duck lake, about one million feet in all. Part of land along this river can be drained easily, and would be fairly good hay land. Moose and bear very plentiful. Weather fine.

Thursday, August 30.—Crossed Black Duck lake, and made long portage in afternoon. Country low and marshy, with scattered bunches of spruce and tamarack. Timber of small size, suitable only for railroad ties or pulpwood. Saw limestone on Black Duck lake, and small hay meadows on Upper Cowan river. Land poor and hard to clear.

Friday, August 31.—Slight frost this morning on Cowan river, but not enough to damage wheat. Weather fine in morning, but rain fell in the afternoon. Country low and swampy, and of little use for farming. Had long hard portage in afternoon in muskeg, with water and mud to the knees, distance about 1½ miles.

The timber is mixed and scrubby and of very little value. Moose and bear very plentiful; also mink and other fur-bearing animals.

Saturday, September 1.—Reached Reed lake, made four portages and had a hard day's work, although we made only about five miles. Country low and swampy, and covered with mixed scrubby timber of no value.

Land, a clay loam, which could be farmed if it were drained. Weather fine, with high wind.

Am leaving bark canoe here, as we do not expect to be bothered with low water after this, and our load is getting lighter.

Moose and bear still plentiful.

Sunday, September 2.—Weather fine and clear, but cool.

Monday, September 3.—Crossed Reed lake in the morning, with fine weather and fair wind. This is a beautiful lake, with many islands. Fish of the following varieties seemed very plentiful: whitefish, jackfish, pike and trout of large size. Water seems to be very deep. On south side of lake is spruce timber of medium size, about one million feet. Country back from lake burned, and growing up with poplar, which should make good pulpwood in a few years. Country very rocky.

Dark coloured granite streaked with white quartz on lower end of lake, and also on river to a distance of six miles below lake. Saw indications of iron on river about ten miles below lake, also good water-power where good business could be done in pulp manufacture at lower end of lake. Banks of this river are about fifty to seventy-five feet, steep and rocky. Saw two moose, also many bear tracks. Geese and ducks very plentiful.

Tuesday, September 4.—Weather fine and warm. Country very rocky. Granite with small streaks of white quartz; also indications of iron.

Splendid water-power above Wekusko lake, very easy to develop.

Mixed spruce and poplar of small size suitable for railway ties or pulpwood on north side of Wekusko lake. Country back from lake and river seems to be all burned. Banks of river higher and more rugged, reaching one hundred feet in some places. Small amount of good land near river. Clay loam, but only in small patches.

Wednesday, September 5.—Weather fine and warm. Made five portages past falls on river, all of which would make fair water-power.

Country much the same as yesterday; rough and very rocky in places, and light sandy loam in other places, with small jackpine and tamarack and small bunches of spruce near the river. The spruce is suitable for milling. Country back from river burned, and very difficult to travel through owing to the fallen timber. This must have been a good timber country before it was burned, and will soon be covered with young trees again if fires can be kept from running.

Saw good slate at falls about twenty miles below Wekusko lake on Grass river, and granite mixed with white quartz on lower end of the lake and on river below lake.

There are small patches of fair land in places, suitable for raising vegetables and garden produce. Fish are very plentiful in lakes and rivers.

Climate seems to be good. Saw butterflies. Hornets and other insects seem plentiful and are still very active. Leaves are green and no signs of any severe frost yet. Saw large black bear and heard timber wolves howling. Bears and moose seem plentiful here.

Thursday, September 6.—Fine and warm. Saw beaver on river to-day, also moose and many ducks and geese.

Country low, but some good land in places. Soil is clay loam mixed with sand, also there are some good hay meadows along Grass river, about ten miles above Setting lake.

Saw more quartz along river, also back from river in many places. I think this part of the country may prove rich in minerals when it is properly prospected, as the quartz seems to extend back from the river on both sides and the country has been burned over, leaving the surface of the rocks bare, making it easy for the prospector. Saw a few bunches of spruce timber near river, some of which have been burned by a fire early this season. Fish and game very plentiful.

Friday, September 7.—Reached lower end of Setting lake; weather fine and clear.

Setting lake is one of the most beautiful spots I have ever seen, fully equal to the Thousand Islands on the St. Lawrence, or to the famous Hudson river, and should in time become a great tourist resort.

There is considerable spruce timber around the shores and on the islands of this lake. This spruce would make milling timber of small size, averaging about twelve to fourteen inches in diameter. It is a young, sound, clean lot of timber, and there would probably be ten million feet in all.

Some good wild hay meadows on river above Setting lake and a small amount of good land in spots. Granite mixed with a small percentage of quartz covers the greater part of the country to-day.

Lynx, bear, moose and other animals are plentiful and there is fish in great abundance.

Saturday, September 8.—Reached Keewatin to-day. Weather fine and very hot, must have been 90° in shade at 4 p.m. Camped on river about twelve miles above Paint lake. Made six portages, two of which were around falls where good water-power could be developed. The river takes a drop of over thirty feet at each fall.

Small bunches of spruce and poplar grow along river, but back from the river the country is burned. Some fairly good land, but generally it is very rocky and rough.

Banks of river higher than yesterday, in some places one hundred feet above water.

Saw two moose and some mink. Ducks are here by hundreds and fish are very plentiful.

Sunday, September 9.—Weather fine, but there was a very heavy thunder storm last night.

Monday, September 10.—Reached Paint lake to-day. Weather fine and warm. Crossed to north side of lake in the afternoon. There are quite a number of islands here, with narrow channels between, with rocky shores and small mixed timber of very little value. A small amount of good land on north side of lake. Country back from lake burned the same as farther up river, but growing up again with poplar and other trees. Fish plentiful. Quartz still in sight, but not as plentiful as farther up river.

My Indian guide has not been down Grass river below Wekusko lake before, so is not familiar with channels, which makes travelling very tedious and slow.

Tuesday, September 11.—Fine in forenoon, but rained in afternoon. Spent to-day cruising on north side of lake, but found nothing of any value. Laid up for rain in afternoon. Saw a bear and some lynx and many moose tracks.

Wednesday, September 12.—Laid up with rain and wind to-day in forenoon. Crossed lake in afternoon. Saw fairly good bunch of spruce on south side of lake. This timber is of small size suitable for railway ties or pulpwood. Camped at outlet of river and will start on return trip up river to-morrow.

Weather cold this evening.

Thursday, September 13.—Made good run up river. Camped at lower end of Setting lake. Weather fine, but cold, with quite a heavy frost this morning. Leaves are falling and it begins to look like autumn. Made six portages, none of which was over a quarter of a mile.

Friday, September 14.—Made forty miles up river with fair wind. Camped at mouth of Mitishto river. Weather cool and cloudy, with slight rain.

Saturday, September 15.—Rained all day, so did not move out. Caught some very good whitefish and salmon trout. River seems to be teeming with them, also with jackfish and goldeyes.

Sunday, September 16.—Weather clear and cool.

Monday, September 17.—Weather clear and still cool, but no frost. Shot a timber wolf, and saw some lynx and beaver work on the river. Moose and bear very plentiful.

Tuesday, September 18.—Reached lower end of Wekusko lake. Weather cool and cloudy. Saw a bear. Moose and fish plentiful. Saw two beaver houses on bank of river.

Wednesday, September 19.—Weather clear and cold. Crossed Wekusko lake in forenoon and camped below Reed lake. Saw more indications of iron on river to-day and am of opinion that there will be iron found in this part of the country.

Thursday, September 20.—Made nine portages in forenoon below Reed lake.

Crossed lake in the afternoon, reaching the portage between Reed lake and Methy lake in the evening. This portage is six miles long so expect hard work to-morrow.

Friday, September 21.—Rained during the night, and at times to-day. Got our outfit and canoe over portage and camped on Methy lake. Land light and sandy and of little value for farming purposes. Timber largely jackpine and tamarack of small size. A small part of it suitable for railway ties.

Shores of Methy lake low and rocky, with white quartz showing in places on south side of lake. Saw a black bear and many signs of moose.

Saturday, September 22.—Crossed File lake in forenoon and camped on File river below Loonhead lake. There is more muskeg here than on Grass river. Small scrubby mixed timber is seen which, with the exception of a bunch of spruce at lower end of Loonhead lake is of very little value. Of this there may be five hundred thousand feet. The trees are of small milling size, averaging twelve to fourteen inches in diameter. Country back from river has been burned at the same time as country near Grass river. Fish seem to be abundant in File and Loonhead lakes. Weather fine but cool. Leaves falling fast.

Sunday, September 23.—Weather fine and cool. Fish plentiful in river near camp. Low land seems to be muskeg and high land seems to be rocky at this point.

Monday, September 24.—Wet and foggy to-day. Camped on File river above Burntwood lake. Country on this river low and muskeg in some places and rough and rocky in others, with a small percentage of fairly good land in small patches. Saw no timber of any value and do not consider this part of the country as good as country around Grass river. Fish are very plentiful, but moose, bear and other animals seem to be scarce, and all the country that I have been able to walk through has been burned, with exception of spots near lakes and rivers where fire was stopped by water.

Tuesday, September 25.—Ran down File river this forenoon, but Indian guide has not been on File river previous to this. This river has many channels, and is rather baffling in some places, and as much time is likely to be lost in finding our way, I think it best to return up river from here and explore country along the upper Grass and Goose rivers to Cumberland lake. Camped on river below Loonhead lake. Weather fine in forenoon but bad thunder storm in afternoon.

Wednesday, September 26.—Reached Methy lake to-day. On way up saw no timber of any value except that already described at Loonhead lake and very little good land. Weather fine, with high wind on File lake. Very rough crossing the lake but no accident.

Thursday, September 27.—Weather fine, with wind still high. Reached the long portage in forenoon, crossed and camped on Reed lake. Moose tracks very plentiful.

Friday, September 28.—Fine weather, wind still high. Crossed west end of Reed lake in forenoon and ran up Grass river about half way to Elbow lake. Good spruce and poplar timber above Reed lake near river. Trees of good size. About two million feet can be got here, balance of country burned.

Some small spots of good land but country generally rough and rocky, with some muskeg.

Saw a little white quartz to-day, but not as plentiful as at Wekusko lake. Made three portages over small rapids. Fish very plentiful.

Saturday, September 29.—Weather fine. Heavy frost in morning and cold all day. Saw some good spruce on river to-day, but only about two hundred thousand feet. Country back from water is burned and green timber only along lakes and rivers. Country to-day rougher with high hills on both sides of river below Elbow lake, very rocky with soil nearly all burned off, leaving rocks bare in many places.

White quartz cropping out again along the river below Elbow lake and also on lake in considerable quantities. What I saw does not impress me as being rich, but there is a wide field here for prospecting. Crossed Elbow lake about noon and camped on river below Cranberry lake.

Moose, bear and other animals not as plentiful as on the lower Grass river. Country between Elbow lake and Cranberry lake largely muskeg.

Fish very plentiful all the way up this river.

Sunday, September 30.—Cold and windy. Leaves all off trees, and it begins to look like winter. Caught some very nice lake trout near camp.

Monday, October 1.—Rain and fog. Camped on Cranberry lake. Saw some fairly good spruce timber along lower end of this lake in bunches of one hundred thousand feet. Think there would be one million feet in all. Country rough and very rocky. A few small pieces of good land and some muskeg.

Saw one moose. Many moose and bear tracks near lake.

Tuesday, October 2.—Rained all day. Did not move camp. The worst storm of trip.

Wednesday, October 3.—Still raining with high wind. Still in camp here.

Thursday, October 4.—Snowing to-day, quite hard, but not cold. Camped about half way up lake. Saw very little timber or good land, and country burned as before.

Friday, October 5.—Snow fell in forenoon and rain in afternoon. Ground covered with snow in morning, but gone by evening. Reached portage between Cranberry lake and Athapapuskow lake in the evening. Country rough and rocky with poor growth of scrubby timber of little value. Some muskegs near upper end of lake and some small hay meadows.

Moose and bear tracks plentiful. Fish in abundance.

Saturday, October 6.—Rain in forenoon; bright afternoon. Crossed portage one and one-half miles into Athapapuskow lake in the morning and reached Goose river, about five miles on Athapapuskow lake, by noon. Saw some small bunches of spruce near portage on Athapapuskow lake, also on Goose river, but only in very small quantities, as this country has been burned as before described. Made six short portages in afternoon and camped on Goose river above Goose lake.

Whitefish are so plentiful in this river that they can be killed in any number with sticks. The water is very shallow in places, being only six inches to one foot in depth, and the fish seem to cover the bottom. I think this must be their spawning ground.

Some fairly good land on lower part of river to-day in small parcels, but country generally rough and rocky.

Moose and bear signs not as plentiful as on Cranberry lake. Quite cold this evening.

Sunday, October 7.—Cold in night and early morning, but began to rain about 10 a.m. There was ice on water along river banks in morning and ice on water pails about three-quarters of an inch in thickness. This was the first really cold night of season.

Fish are continually playing up and down river in front of camp to-day.

Monday, October 8.—Snow and very high wind. Camped near lower end of Goose lake. Country about upper end of Goose lake low and boggy and of very little use. Saw some small bunches of spruce and poplar near north side of lake, but only in small quantities. Limestone on south side and west end of this lake. Bulk of country burned. Fish plentiful.

Tuesday, October 9.—Very cold. Ice on water along shore of lake and snow on ground. Warmer in afternoon. Crossed end of Goose lake in the morning and ran down Goose and Sturgeon rivers to Cumberland lake, reaching lake in the evening. Quite a large tract of fairly good land along Goose river below Goose lake, and also on Sturgeon river between the mouth of Goose river and Cumberland lake. Soil is a clay loam mixed with a little sand. This land has brush and small trees, mostly poplar, but would not be hard to clear. Have seen no open prairie north of the Saskatchewan.

There seems to be limestone on Cumberland lake in considerable quantities, but banks of lake are not high, being in most places not even twenty-five feet above high water and in some places are quite low. The limestone in this part of the country may be of great value in time.

Wednesday, October 10.—Cold in morning, wind blowing a hurricane from west until noon, when it calmed a little so we could venture out on lake. We ran down to lower narrows, reaching there in the evening. Weather fine.

Thursday, October 11.—Fine and warm. Reached Cumberland House at noon and ran down the Saskatchewan in afternoon on way to The Pas. Camped about twelve miles below Cumberland.

Friday, October 12.—Fine and warm. Made good run. Camped ten miles below the 'barriers' on river. Saw three moose crossing river. Bear and fox seem plentiful.

Saturday, October 13.—Clear and cold. Reached The Pas in evening. Water very low, which makes travelling very slow.

Sunday, October 14.—Cool and cloudy with slight rain in the evening.

Monday, October 15.—Cold and windy. Raining in afternoon. Disposed of nearly all my outfit in forenoon and started at 3.30 p.m. to walk out to Etoimami, ninety miles along the right of way of Canadian Northern railway carrying provisions for three days, but have neither blankets nor tents. Camped in open about six miles from The Pas. Weather cleared up in the evening and we spent fairly good night. Country here low and largely muskeg. Walking very bad.

Tuesday, October 16.—Cloudy but dry. Made twenty miles. Road very wet and country nearly all muskeg. Camped in the open again. Weather cold, but dry. Had a good night.

Wednesday, October 17.—Cloudy again, but cool and dry. Made about twenty-five miles. Country still muskeg and wet in places. Camped in open again.

Thursday, October 18.—Country low and wet in forenoon, but getting better in afternoon. Saw some good spruce near track, also poplar. Camped in open about eighteen miles from Etoimami.

Friday, October 19.—Weather fine. Reached Etoimami at 2 p.m.

Saturday, October 20.—Left Etoimami at 4 a.m. and reached Prince Albert at 2 p.m. No train till Monday.

Sunday, October 21.—In Prince Albert.

Monday, October 22.—Left Prince Albert on morning train and on reaching Warman found westbound train eighteen hours late.

Tuesday, October 23.—Reached Strathcona in evening.

In conclusion I would say that for the amount of territory travelled over, I think this is the best sportsman's country in the world to-day. Good time can be made travelling with a canoe on all the waters I was on. Game and fish are abundant everywhere. During the trip I saw ten moose, six bear, one deer, one timber wolf, over a dozen lynx, quite a number of mink and other fur-bearing animals, and ducks and geese innumerable. This should become a great tourist resort when better known.

As a farming country: the summer seems to be good, and where good land is found there should be no trouble in raising good crops of all the hardy grains and vegetables, but the greatest drawback to farming would be the difficulty of making wagon roads from place to place, as the country between the spots of good land is rough and rocky.

As a lumber country: the fires seem to have burned over nearly all the country, and I was not able to walk far enough into the interior to find any land not burned. From the information I gathered from Indians and trappers, I would conclude that this burned land reached from Grass river to Burntwood river with the exception of small areas along the lakes and rivers. There is a growth of young timber coming up since the fire which may be of value in time.

As a fishing country, it is good. The fishing industry should be good as soon as a railway is built, as there are immense waters teeming with fish.

As a mineral country I would say that there is a wide field for prospectors. In the country I travelled over I saw indications of gold, silver, iron and limestone. Indians and white men from the north tell wonderful stories about a place called Indian lake, north of Nelson House, also about an island on Burntwood river, where minerals of different kinds and oil are said to exist. About the route of the railway to Hudson bay I would say that preliminary survey is already run from The Pas to the southeast of Reed lake and my observations would lead me to think that this is the best route that could be followed to that point. From there on, I think the road should cross Grass river between Reed lake and Wekusko lake, and down the north side of Grass river and Setting lake, passing north of Paint lake. This route would take the railway through the best part of the country where there would be the most local traffic.

I might say that in travelling in that part of this country I have found the Indians very trustworthy and reliable, and have found the Hudson's Bay Company's officials, also Revillon's traders, to be very obliging and willing to give information and help in every way. Had it not been so, I could not have travelled as far as I did in the limited time at my disposal, having travelled at least eleven hundred miles by canoe, made eighty-three portages, and spent a considerable part of my time travelling on foot. We had no accidents, no sickness and very little lost time, except in Cumberland and The Pas waiting for a guide.

I sold the outfit at The Pas, getting thirty-four dollars for the rifle, eleven dollars and fifty cents for the shot gun and five dollars for the compass, but the other things, including the canoe, which was somewhat damaged, I sold cheaper and the bark canoe was left at Reed lake.

I have the honour to be, sir,
Your obedient servant,

J. W. McLAGGAN.

APPENDIX No. 30.

REPORT OF GEO. McMILLAN, D.L.S.

INSPECTION OF SURVEY CONTRACTS IN CENTRAL ALBERTA.

OTTAWA, March 1, 1907.

E. DEVILLE, ESQ., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report on the examination of surveys in the Edmonton district during the season of 1906 under instructions from you dated May 11, 1906.

After having collected what information I could with reference to the contracts, I left Ottawa on May 15, and arrived in Edmonton on the 19th. I at once called upon Mr. P. R. A. Belanger, D.L.S., as instructed, and proceeded to outfit. On May 29, I left Edmonton for contract No. 15, of 1905, and on the way made a traverse of part of Batty lake. This journey involved a trip of one hundred and thirty miles, of which the last twenty miles of trail were abominable. The townships in this contract (townships 59, 60, 61, 62, 63, and 64, range 12, and townships 58, 61, 62, 63 and 64, range 11, west of the fourth meridian) are almost entirely wooded with poplar. Townships 63, ranges 11 and 12, are traversed by Beaver and Little Beaver rivers, which come together in section 20, township 63, range 12. On Beaver river there are several rapids and considerable water-power might be developed. There are no settlers as far as I have seen, although the soil is of a good quality and will be suitable for farming as soon as the timber is cleared off. On the return trip I made a traverse of part of the Upper Mann lake and arrived back in Edmonton on July 12.

On July 14, I proceeded to contract No. 12 (townships 59, ranges 1, 2 and 3, township 60, range 1, west of the fifth meridian, and townships 59 and 60, range 27, west of the fourth meridian) and reached there on the 19th. I spent six days in the examination thereof, the weather being most unfavourable. In these townships many families were settled, a majority or all of whom had squatted and during my stay there land seekers were swarming into the vicinity. The soil is suitable for farming purposes, and the water supply is abundant, the townships being traversed by Paddle and Pembina rivers. There are some patches of large timber, but a large percentage of these townships is covered with small poplar and willow scrub.

I next proceeded to contracts Nos. 19, 17 and 20 and examined them in succession. Contract No. 19 is composed of townships 54, 55 and 56, range 6; contract No. 17, of townships 54, 55 and 56, range 7, townships 53 and 54, range 8, and township 53, range 9; and contract No. 20, of townships 55, 56 and 57, range 8, all west of the fifth meridian. The old pack trail leading from Lake St. Ann northwestward has recently been cut into a wagon road and a ferry established across the narrows of lake St. Ann. These townships are largely wooded and very densely so in the vicinity of Pembina river. Seams of coal crop out in several places along the Pembina, and as far as I have seen remain undeveloped. In contract No. 19 there are many large hay meadows, but not much prairie. Contract No. 20 has been burnt over in large sections and a luxurious growth of grass appears among the dead timber and scrub. Contracts 19 and 20 are, I think, specially suited to farming and stock-raising. This completed my examination of the 1905 contracts, and I returned to Lake St. Ann, arriving there on August 28.

According to instructions I next proceeded to townships 60, ranges 3 and 4, west of the fifth meridian, being part of contract No. 15, of 1906. A large percentage of these townships has been burnt over and has grown up with small poplars and willow scrub; the soil is of a good quality. There are small berths of spruce timber of considerable importance in both these townships. There are some settlers in township 60, range 3.

I next visited the adjacent contract, No. 20, composed of townships 56, 57, 58 and 59, range 4, west of the fifth meridian. Townships 58 and 59 are especially suited to stock raising and in the vicinity of Paddle river large herds of cattle are reared. Township 57 is traversed by Pembina river, and is largely covered with timber and heavy windfalls, the south and eastern part being largely swamps and muskeg including a valuable berth of spruce timber. Township 56 is very rolling and better suited to stock raising than farming. Townships 56 and 57 are traversed by a wagon trail leading from Lac la Nonne northwesterly and known as the Grand Trunk trail.

I examined township 57, range 5, west of the fifth meridian, of contract 16. This township, as far as I have seen, is suitable for farming and stock raising, the timber being light except in the close vicinity of Pembina river. There is good grazing even in the woods, and several quarters have been squatted upon.

I next visited contracts Nos. 1 and 21. Contract No. 1 is composed of townships 49 and 50, range 6, and contract No. 21, of townships 54 and 55, range 7, townships 50 and 51, range 6 and township 50, range 5, all west of the fifth meridian. They are traversed by Saskatchewan river and the part north of the river being fairly good soil is somewhat settled. South of the river the soil is light and includes a timber limit. Lumbering is pursued there. There are large deposits of beautiful sandstone on the Saskatchewan and some quarries have been surveyed. I completed this work on November 12 and left for Edmonton, arriving there on November 16. On November 14 and 15 there was a heavy snowfall, which necessitated a change in my transport. I stored the wheeled rigs and bought two sleighs. I also received one heavy horse and a set of double harness from Mr. G. J. Lonergan, D.L.S. I arranged for the keeping of five horses till I should return, and left for township 58, range 21 and township 59, range 20, west of the fourth meridian.

Both of these townships are as yet but sparsely settled. They are well wooded and the soil is good. In township 59, range 20 there are some fine hay meadows. I next proceeded to townships 61, ranges 25, 26 and 27. The soil in ranges 25 and 26 is of a light nature but both contain some valuable spruce timber. In section 19, township 61, range 25 there is a sawmill which is of great service to settlers in the adjoining townships. The soil in township 61, range 27, is good, and large quantities of hay can be procured in the vicinity of Pembina river. My last work was the examination of townships 58 and 59, range 27, being part of contract No. 14. These townships have become well settled. They comprise a good farming district. In section 5, township 59, range 26 there is a large sawmill in operation.

This concluded my work for the season, the winter being somewhat severe and the snow quite deep, horses would be unable to continue without shelter. I wired for instructions and disposed of the outfit accordingly. I reached Ottawa on January 24, 1907.

I have the honour to be, sir,
Your obedient servant,

GEO. McMILLAN, *D.L.S.*

APPENDIX No. 31.

REPORT OF C. F. MILES, D.L.S.

SURVEYS AND RESURVEYS IN SOUTHERN ALBERTA.

TORONTO, January 31, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit my general report on last season's (1906) operations in southwestern Alberta under your instructions, dated April 18, June 7, 18 and 22, and August 25, 1906.

I left Toronto April 28, arriving at Calgary May 2 ; I had previously sent my cook and another man to Macleod to collect my outfit stored at Stavely and Nanton. It was the 5th before I could obtain my outfit from the railway company, and having to repair my wagons, it was the 9th when I pulled out for township 21, range 27, west of the fifth meridian. Two of my men with a wagon load of supplies went by trail to High River to await my arrival there.

Commencing work on the morning of May 10, I measured the north boundary of section 19 to the northeast corner of this section, where no trace of a monument was found ; it had fallen into a ravine and been washed away. I then continued this line east along the north boundary of section 20, to the northeast corner of this section. I retraced the lines of the east boundary of section 19 and east boundary of the southeast quarter of section 30, thus obtaining the intersection of the two lines for establishing the northeast corner of section 19. After traversing the south side of Bow river in section 29 and also the island, or what would be an island in high water, I had the necessary data for calculating the required areas.

After completing this work I left here on the 14th for High River, but finding that one of my mares had been kicked so severely, that she could not move a step, I exchanged her for another horse with Mr. Robert Begg of Dunbow, paying him fifteen dollars on the deal. I have since heard that the mare (Jessie) is still lame.

We left High River on the following day for township 18, range 3, west of the 5th meridian, but owing to continuous rain and snow storms we did not reach there until the 18th. From the following day on there was snow and rain daily up to May 30, preventing me from putting in more than four full days of field work. I completed the survey of this township north of Highwood river by tieing in with the survey of the south side of the river.

Owing to continuous rains the river could not be forded. I therefore moved north into township 19, range 3, west of the fifth meridian (all my work from May 15 lies west of the 5th meridian). I found four settlers in the part of the township that I surveyed. On the west side, the township is very hilly ; on the east side, too, there is a range of hills. A surveyed trail traverses sections 1, 12, 14 and 23, but we found it impassable, for in the two latter sections it passes through continuous swamps. The proper place for this trail to be located is along the ridge through sections 13 and 24, which sections the present travelled trail traverses. The part of this township, within the limits of my survey, is principally adapted for grazing. The remaining part of the township appears to be more wooded and also more hilly. Cattle appear to thrive, owing to the luxuriant growth of grass and plentiful supply of water. It is doubtful, however, if any crops could be raised here for though the soil is all that could be desired, the climatic conditions are not favourable for the ripening of grain. Potatoes and the more hardy vegetables have been grown successfully in the eastern sections, but a crop cannot be depended on at all seasons. This statement holds good in respect to nearly all townships that have come under my observation within the third range. From township 19, I moved into township 20 in the same range, where I completed the subdivision in the northerly part. It is mostly hilly and rolling with valleys running between the ridges ; the soil is good and there was some grain growing here in the easterly part of the township but not on a large scale, most of it being cut for green feed.

I have seen some fine vegetables that were grown in the northeasterly quarter of this township. There is a good deal of brush and some poplar and spruce on the northern exposure of the hills. After finishing the work here we moved to township 18, south of Highwood river, where I re-ran the east boundaries of sections 20, 27 and 26, and the north boundary of section 21, tieing in with the survey lines from the north of the river. This portion is also hilly and brushy and although the soil is good it is adapted only to stock raising. I then moved camp to section 2, where I surveyed the east boundaries of sections 2 and 11 and sections 6 and 7 over high rolling and hilly prairie. This is a fine grazing country and well watered by springs. While here, I received your instructions, dated June 18, and proceeded with four of my party to the north boundary of township 19, range 3. There I retraced the north boundaries of sections 33, 34, 35 and 36, made monuments at the northeast corners of sections 34 and 35 and re-established the east boundary of the northeast quarter of section 34, also the east boundary of section 3 in township 20.

I rejoined my party July 5, who in the meantime had moved to section 3 in township 17, where they had been compelled to stop running the lines owing to an accident to the instrument. Here we surveyed the east boundaries of sections 3 and 10, 4 and 9, 5 and 8, also the north boundaries of sections 9, 10 and 11. These consist of rolling prairie, with some brush more particularly on sections 5 and 8. In the vicinity of Pekisko creek along the south boundary of this township there is quite a fringe of large poplar and balm of Gilead. This district appears to be given up entirely to ranching, for which, to judge by the vegetation it is admirably adapted. As most of these lands are stated to be under lease and no new settlers may be expected to enter, the pasturage privileges can more conveniently be regulated and in accordance with the requirements of those specially interested. The soil consists of a good depth of black loam underlaid with clay in the bottom lands and with gravel and shale on the highlands.

On July 9 we pulled out for the southeast corner of township 15, range 2. After cutting out the jog, 9 chains and 20 links, we planted a flag to line in with the east, and then moved on to the southwest quarter of section 1, township 15, range 1, through a very hilly country and over a rough trail, causing the upset of a wagon in a creek. Having to use this trail again on various occasions, I had it repaired, entailing two men's work for a day. The following day I located the southeast corner of township 15, range 1, on the fifth meridian and cut out this line south for about a mile in order to turn off the angle for the south boundary. I completed the subdivision of this township by running the east boundaries of sections 3 and 10, 4 and 9, 5 and 8, and 6 and 7, over very hilly country, covered in part with a dense growth of willow and second growth poplar. There is some spruce in this district but most of it has been cut for a portable sawmill, that has been operating just south of the south boundary of section 1. There are six settlers within the limits of my survey, five of whom made out statutory declarations, the sixth, on an odd-numbered section, the southwest quarter section 1, being absent. They are all new arrivals, occupied in ranching on a small scale. They are also growing vegetables, but most of their potatoes had the tops frozen on the morning of August 4.

I omitted to mention in the proper place that on June 18, in compliance with your instructions, I tied in the old surveyed trail in township 20, range 3, with the interior surveyed lines.

On July 18, I found it necessary to dismiss four of my men, who proved most inefficient and whose services I was glad to dispense with. I paid them off according to their signed agreements and sent them in to Nanton, the nearest railway station. Their places were filled a few days later by a better class of men, for three of whom I had to send to Calgary, men being very scarce on account of general haying operations then in progress.

On July 23 I moved to the northwest quarter of section 6, in township 15, range 1, from where I finished the subdivision and also subdivided part of township 15 in range 2. In locating the southeast corner of township 15, range 2, and the northeast corner of township 14, range 2, there was a surplus of 3 chains and 2 links. Later I found that the east boundary of the latter township was deficient in measurement. The soil in township 15, range 2 is black loam with clay subsoil, covered to a considerable extent with willows, scrub and poplars, mostly second growth. There are no settlers, but the locality is overrun with cattle owned by ranchers in adjacent townships. The country is very hilly and therefore not specially adapted for farming, even if the climatic conditions were favourable, which is extremely doubtful. Much of this township I learn is under lease, or has been purchased by ranchers, who make no effort to cultivate the soil.

On August 6, I moved camp to section 28 in township 14, range 2, surveyed the north boundary and then ran a trial line from summit to summit, without much cutting, along the east boundaries of sections 4 to 33, closing on the north boundary of the township, when I discovered that an error existed somewhere, which I finally located in the south boundary of the township as already explained in my letter to you of September 27 last. There are only three settlers in this township, all of whom are engaged in stock-raising, for which this township is particularly suitable. No cultivation of any kind has been attempted here, and although the soil in the valleys is very good, I am led to believe that the crops will not ripen. It is traversed by high and more or less wooded ridges. Between the ridges there is good grazing and large quantities of hay is cut annually in the valleys. There is a good supply of water in the creeks. Willow creek from 50 to 100 links wide and about one foot deep, meanders all through sections 29, 28, 27, 26 and 25, and another one, Rice creek, a tributary to Willow creek, runs through sections 10, 15, 22, 23 and 26. This creek is so named, not because wild rice is found along its banks, but after a settler of that name, since departed. Other numerous springs have their sources in the ridges already referred to and another creek takes its rise on section 12, running easterly into Willow creek.

Most of the available timber on the ridges has already been cut by the neighbouring settlers and ranchers. Therefore, but a small quantity is available, indeed barely sufficient for others that may settle here.

On August 28 I received your telegram instructing me to proceed to the fourth base line across the Livingstone range and valley; believing it to be urgent, I broke camp on the 30th, and moved to section 7, township 13, range 2, as far as I could travel with wagons. While some of my party were looking for the line, the north boundary of township 12, range 2, I drove with a couple of men to the east boundary of section 36, township 13, range 2, to check an observation, in which I succeeded. On my return to camp no monuments had yet been dicovered. On the fourth base finally a wooden post in mound was found at the north east corner of section 35, township 12, range 2, and we afterwards found a picket lying on the ground at a pile of stones on a high ridge about a mile west. From here we traced the base line (instrumentally) to the wooden post and mound at the northeast corner of section 13, township 12, range 3. It was found in a dense poplar bush, apparently grown up since the first surveys, but all traces of a line were completely obliterated. There we had to pack the outfit with horses, running west about two miles, having previously attempted an observation of Polaris, which proved only partially successful. At the above corner I laid off the prescribed deflection angle, having a back sight of about two miles. Then not being able to get nearer to the work, I moved around to the Indian pack trail by way of section 25, township 13, range 2. In order to facilitate the move, I secured the services of a young man who had previously acted as guide for other parties. We followed the pack trail about half way across the Livingstone range, then left it to strike south over a stony and rocky divide and succeeded in making camp in the valley of a creek running west to Livingstone river and about one mile from the base line. This line crosses one high ridge after another alternating with deep ravines, containing springs and creeks, and all solid timber consisting of spruce, banksian pine and some poplar. The former two attain a diameter of as much as thirty inches and should become of considerable commercial value if the valley of Livingstone river is ever tapped by a railway, which I heard reported was likely to be the case in the early future. There is also said to be coal in the neighbourhood. Different varieties of trout are found in the river, some of those seen by me measuring nearly two feet in length. The open stretches along the valley do not appear of any great extent, the bottom lands being generally more or less bushy and sometimes swampy. The valley proper is not wide, varying from 10 to 40 chains in width. An old north and south survey line was found a few chains west of the river with, at the northern extremity, a four-inch squared post (lying on the ground) marked 'T. B. 600.' Nothing else showed what it delimited, but it presumably marked the northeast corner of a mining location. Owing to unpropitious weather, I secured no satisfactory observation of Polaris, and though I succeeded in obtaining a single view of the star several times, the sky immediately afterwards became obscured, it now being the time for arrival of the early September snowstorm. I did not delay longer than absolutely necessary, fearing I should be snowed in with but a scanty supply of provisions.

Several deer were observed from the pack trail as we were going and returning, and there were also signs of mountain sheep and goat as well as grouse and partridge. Some partly opened stretches were observed along creek bottoms running west into Livingstone river. The river varies from one to two chains in width with an average depth of not much over a foot and is very rapid. I extended my line into the thick woods one mile into range 4, at the terminus of which I considered that I had fully traversed the valley of Livingstone river. A few miles down the valley, my guide informed me that a settler was located and engaged in ranching.

Having completed this survey I recrossed the Livingstone range and returned to township 14, range 2. I finished the subdivision of this township, and also resurveyed a portion of township 13 in the same range. A number of settlers had crowded into the last named township and had made many improvements on lands now said to be leasehold. They state they settled here in good faith, acting on the advice of some land agent, either with or without authority, and believing that this land was opened for settlement. The settler naturally concluding that he had the right on his side, continues in possession, where in the end, after a few months or perhaps a year, he unwillingly realizes that he has no claim or anyway that the ranchers claim is a preferred one. Then, after the loss of his time, his money and hay and his improvements, which latter may consist of house, barn, fencing, &c., he is compelled to abandon all and start afresh in search of another homestead. The rancher may be within his legal rights but if such be the case, the settler should not have been advised to settle or permitted to remain. Very few of the ranchers held leases but enjoyed all the benefits of occupation of large tracts of pasture land with a free run of the same and without expense, but as soon as the settler ventures to locate, the rancher applies for a lease and then, the unfortunate settler, poor as he frequently is, has had his labours and his outlay in vain.

On October 14 we again broke up camp and started for High River. In passing I rechained the east boundaries of sections 2 and 11, 10 and 3, in township 15, range 1. At High River wagons were repaired, horses shod and a new stock of supplies laid in, after which, passing through Okotoks and Millarville by good trails, we reached township 21, range 4. Here we searched for monuments on the north boundary of this township and found a W. P. in mound at the northeast corner of section 32. Thence cutting out the line east and west wherever bush, we found the other monuments. I commenced the subdivision of township 21, range 4, on October 6. The lines previously run in this township were obliterated and had therefore to be opened out anew as they were mostly covered with willow and second growth poplar. There is some good timber here still standing although some of it was cut years ago when a sawmill was brought in and operated on the northwest quarter of section 10. A good sized creek runs southeasterly through sections 30, 29, 20, 21, 16, 10, 11 and 12. There are flats along the creek bottom but these are mostly covered with willow and willow scrub. Good spruce and banksian pine are found in different parts, the heaviest growing along the north boundary near Whiskey creek. This creek is said to have derived its name from several illicit stills which at one time were in active operation along its banks. Bunches of spruce and banksian pine (generally called jackpine here) are found on sections 7 and 8, 16 and 17, 19, 20 and 21, 28 and 29, 32, 33 and 34, 22 and 24. These sections it might be advisable to set apart as timber berths.

The principal timber and larger areas are found in sections 28, 29, 32 and 33. This timber is somewhat difficult of access, but it could be got out by a winter road running southerly along the Morley Indian pack trail ; also by way of the valley of Whiskey creek along which a good winter road might be constructed down to the south fork of Fish creek. This township is not adapted for general farming. It is very hilly and its only value at present lies in its timber and its being suitable to a limited extent for grazing purposes. Many horses and cattle roam here. The grass lands have the appearance of being overstocked, the pasture being very bare in places. There is one settler in an adjoining township who is said to be possessed of a herd of 3,000 head of cattle, who seeing the necessity of retrenchment disposed last fall of 600 head. Another settler also in an adjoining township has 600 head of horses besides some cattle and they all have the run of this township where there are no fences as yet to stop them from roaming.

In order to complete the subdivision of the northerly part of this township I moved around to the southwest quarter of section 36, quite a long detour, it taking me a day to make the move with my outfit. It had been my intention to move up the Morley pack trail which is quite swampy in places, but going down along Fish creek over frozen muskegs, the trail proved so exceedingly rough that I broke an axle of one of my wagons. The roads in the township are mere winter trails and passable only with sleighs and when there is good snow on the ground. A well graded wagon road leads both from Millarville and Priddis to the sawmill that is at present operating on section 25. Much of the timber on this section has already been cut, but there is some good timber still standing in section 24. After surveying the north boundary of this township I borrowed a sleigh and moved my outfit on November 22 along an old tote road to the south fork of Fish creek near a settler on the southwest quarter of section 22, in range 4.

While here I was approached by an engineer asking employment as assistant. He claimed to have been in foreign service for many years and more recently had been running an instrument on the Canadian Pacific railway's irrigation ditch east of Bow river. On the strength of this application I wrote you my letter of November 12, receiving your reply dated the 22nd favourable to my suggestion. I then sent one of my men (an Indian) on the 25th to Morley from where he returned on the following evening with two more Indians. The same day my prospective assistant arrived at my camp and I found he could not qualify nor could I accede to his stipulations. I had now more men than the allowance called for, but I concluded to keep them on for a short time to further the work in this township, and I may here state that better men in a brush township than I had secured in the Stony Indians could not be desired. They are excellent ax or brush-hook men, very willing and good at keeping line. I never tried them at mounding. They may possibly not be quite so efficient with the spade or pick.

This township is very hilly and brushy. The greater part is covered with willows, poplars and spruce and more or less scrubby in the valleys. There is good grazing whenever there are openings and it is well watered. The south fork of Fish creek meanders through sections 18, 17, 21, 22, 15, 14, 11 and 12. There is a number of small springs tributary to it. It averages about twenty-five links in width and about twelve inches in depth. There are some good meadows along the creek, though much of the bottom lands are covered with willows and scrub; but for this it would make an ideal grazing country. There is a settler on the southwest quarter of section 14 who raises only horses, and another settler in the adjoining township east has a cow-camp on the northeast quarter of section 18, where his improvements consist of a log house about 15 x 20, a log stable about 18 x 35 and some fencing. He has a large quantity of hay cut in the valley which he feeds to his cows and calves in winter. No attempt at cultivation has been made, the valley not being adapted for raising crops except oats for green feed and possibly a few hardy vegetables. Wherever there are openings there is a luxuriant growth of grass which makes this township more particularly adapted for stock grazing.

All the townships within the limits of my last season's survey may be classified as grazing country.

In most portions of the district traversed, that is in the wooded country, there is an abundance of game. The deer are of the white-tailed variety. The wooded townships are the chief hunting grounds of the Stony Indians. A number of these visited my camp in township 22, range 3, with the hindquarters of four deer just killed. These, however, I did not buy, having at the time all the provisions necessary. These Indians were members of a large band spending their time hunting and killing deer wholesale. Unless some restrictions are imposed controlling this indiscriminate slaughter, it will not be long before the deer in this region are exterminated. In respect to fish, I should mention that nearly all the streams are well stocked. The principal variety being mountain trout, speckled trout, bull trout and grayling. There are also considerable numbers of mountain grouse and partridge, and in certain localities a few prairie chicken. While subdividing this last township, although the weather was very fine, the frost was severe, having penetrated into the ground the full depth of the pits, and I was compelled to abandon the mounding. The Indians also were anxious to return to the reservation before Christmas, and as the one month of two of them was up, I allowed them to leave on the 19th. After they had departed, I rounded up the work and broke up camp on December 20, paying off some of the men on the 21st. Those that took charge of the horses and outfit that had to be taken into wintering quarters, on December 24, were given checks for the several amounts due them.

I had previously made arrangements with Mr. Howe, near Priddis, who also has the winter cow-camps on section 18, in township 22, in range 4, for the wintering of my outfit.

I left Calgary on December 21, arriving home on the 25th.

I have the honour to be, sir,
Your obedient servant,

C. F. MILES, *D.L.S.*

APPENDIX No. 32.

REPORT OF A. D. MOODIE.

EXPLORATION OF THE COUNTRY BETWEEN ERWOOD, SASKATCHEWAN, AND THE PAS, KEEWATIN.

LAKEFIELD, ONT., November 30, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I have the honour to report that having received instructions on July 31 from your department to proceed to Prince Albert and there await further orders, I arrived at that point on Wednesday, August 1.

On August 6 I received my instructions, which were to organize a party for the purpose of exploring the region lying between Erwood, on the Canadian Northern railway, and The Pas, on Saskatchewan river.

I had considerable difficulty in procuring men and horses for the expedition, as well as a guide familiar with the country which I was to explore. There were no horses to be obtained in Prince Albert or on the Indian reserves in the immediate vicinity, and I was compelled to send to Duck Lake, forty miles distant, in order to procure them. I deemed it advisable to purchase six animals as we would be obliged to make up light packs, owing to the muskeggy nature of the country we had to traverse. I paid eighty dollars for one animal, eighty-five dollars a piece for three others and ninety dollars a piece for the remaining two. I also purchased a second-hand stock saddle for use in case of any emergency.

My instructions from your department left me a certain degree of latitude as to what route I should adopt, and as I had been unable to secure a guide in Prince Albert, but had heard of one living about twenty-five miles north of Tisdale named Thomas Ballantyne, I decided to go that way and interview him. We therefore shipped our heavier supplies by the Canadian Northern railway to Erwood, and proceeded with light packs across country to Mr. Ballantyne's homestead. I was successful in engaging his services, and found his knowledge of the district of the greatest value to me throughout my work.

It took us eight days to journey from Prince Albert to the Canadian Northern railway right-of-way, and as we had about ten days' provisions in hand on our arrival I decided to explore a certain portion of country before going into Erwood for the balance of our supplies.

The part that I explored first was that section lying between Leaf lake, on the east, and the Canadian Northern railway right-of-way on the west. Our work carried us as far north as the north end of Leaf lake and south to the main line of the Canadian Northern railway. My investigation of this section proved that it is mostly unfitted for agricultural purposes, mossy muskegs sparsely clothed with spruce and tamarack scrub, and gravel ridges covered with spruce and light poplar being the prevailing features.

The poplar is suitable for pulpwood, and amounts to about three million feet. It is practically of no use for any other purpose, the best of it being only about eight inches in diameter. Tamarack and small spruce amount to about one million feet. Spruce suitable for lumbering purposes grows in scattered quantities. It would be a generous estimate to assert that there are four million feet within this particular area.

Moose, caribou and bear are very numerous. We did not see many of the smaller fur-bearing animals, but I was assured by the trappers and Indians whom I encountered that they are very abundant.

The quality of hay in the marshes is distinctly poor. It is what is known as muskeg hay. Judging from the dislike of our horses to it, it is unsuitable for animals of a domestic breed. The only pasture for which our horses showed any partiality at all was the goose grass which grows in scanty patches on the gravel ridges already referred to.

Small streams are plentiful throughout this section, but as the land is low and of a marshy nature it would be impossible to erect dams on any of them for industrial purposes. They are, moreover, narrow, shallow, and full of rapids. Leaf lake is the largest body of water in this vicinity, with the exception of Red Deer lake, which, however, did not come within the scope of my investigations. It is a fine sheet of water, being about the size of a township in extent. On the northern and western sides, it is bounded by vast muskegs, but on the east and south the timber, the quality of which I have already stated, runs almost to the water's edge. Its waters are shallow, having an average depth of about eight feet. The lake contains a moderate supply of pike and sucker . On finishing this portion of my work, I decided to go to Etoimami, striking in by the well known pack trail that runs from Etoimami to The Pas.

Etoimami is eight and a half miles from Erwood, and we brought in our supplies from the latter point by means of our pack horses. We arrived in Etoimami on August 29, and having obtained our supplies, gave our horses a day's rest before setting out on the second portion of our expedition. Our supplies proving too bulky for our animals, I engaged a team which was travelling the same way as ourselves to cart six hundred weight of the goods as far as 'Thirty Mile Store.'

On September 1, we set out for 'Thirty Mile Store,' on the Canadian Northern route, my object being to first explore the country lying to the north of that point. My reason for doing so was that the season was well advanced, and there was danger of seriously damaging the horses' feet if frost settled on the muskegs. We arrived at 'Thirty Mile Store' late in the evening of September 2, and here I met Mr. Stewart, the leader of the companion exploring party, who was utilizing this point as his base of supplies. Prior to starting out in earnest on my work, however, I made a preliminary exploration of the ridges to discover if it was at all feasible to take horses through that country. Our guide had informed me that it was quite possible to do so, but I found that the off-take ditches of the Canadian Northern railway, while they had drained the western portion of the country, had flooded the eastern, and it was only when we arrived at Little Pasquia river that I found it possible to make use of our animals. I had been obliged to leave behind me at 'Thirty Mile Store' a man in charge of two of our horses, which were suffering from sore backs. In order to get our horses to Little Pasquia river we were compelled to make a succession of corduroy roads across the muskegs, which proved a laborious and lengthy undertaking. This work, combined with the exploration of the intervening tract of country, took us eighteen days to accomplish.

We started on our return journey from Little Pasquia river on the morning of September 21, but encountering an open muskeg, over which it was impossible to take the horses, and being, moreover, short of provisions, we cached our packs and left the animals to pasture on a ridge about eight miles from the station. By doing so we were enabled to reach 'Thirty Mile Store' at 5.30 p.m. the same evening. On the following morning September 22, I sent the men back to bring in the horses. To accomplish this they were obliged to make a long detour with the animals around the muskeg, an undertaking which occupied them three days.

Having spent a day in repairing pack saddles, &c., we started out from 'Thirty-Mile Store' on September 26, with our full complement of men, animals and supplies. My destination was Little Pasquia river, where I intended to form my base of supplies, as I had discovered that that was the only point from which that part of the country could be suitably explored. I found a convenient base eighteen miles a little north of east of 'Thirty Mile Store,' and having cached our goods proceeded with my work of exploration.

The region is very similar in its characteristics to that we first explored, but the muskegs are more dangerous, whilst the timber is entirely of a scrub quality, being composed of dwarf spruce and tamarack.

Being shorthanded on account of the nature of the country, I took the opportunity on September 28 of hiring two Indians whom I found hunting in the neighbourhood. I paid them at the rate of two dollars per day for their services. On October 11 I despatched two of my regular party back to 'Thirty Mile Store' in charge of the horses instructing them to remain there till my return, and proceeded to explore the district on foot. The horses had been most serviceable as far as seven miles east of 'Fifty Mile Store,' but on reaching this point the dangerous quality of the muskegs, combined with the advent of frost rendered it hazardous to employ them any longer.

I concluded the exploration of this portion of my territory and returned to 'Thirty Mile Store' on October 18. On October 17 I had paid the two Indians their wages, the sum total amouting to eighty dollars. When I arrived at 'Thirty Mile Store' I received a letter from Mr. Stewart, informing me that he had brought from Erwood, a registered letter from the department to myself, and had left it in charge of a local merchant in Etoimami. I set out next morning for Etoimami and obtained the letter which contained a cheque for three hundred dollars, and which in order to have cashed I was obliged to transmit to Prince Albert.

The general character of the country from the north end of Leaf lake to The Pas and as far as thirty miles east of the grade which is already constructed to the latter point, is very similar in its features to that of which I have already informed you in this report. The timber however, is of somewhat better quality, and in greater quantity, one ridge alone which lies about half way between 'Thirty Mile Store' and Little Pasquia river, containing about two million five hundred thousand feet of spruce, suitable for lumber. There is, in addition on the same ridge, about three million feet of white and black poplar, and one million feet of tamarack suitable for ties and telephone poles. The average measurement of the spruce is about twelve inches, of the poplar seven inches, and of the tamarack nine inches. One particular spruce which I measured was one hundred and three feet in height and nine feet two inches in circumference.

It would be well to state here that what I have denominated 'ridges' throughout this report are in reality only slight elevations of from six to ten feet above the muskeg. There are only seven important ones in the whole region that we traversed, and these are from two to three miles long and about a mile wide on the widest part. There are also five smaller ridges which contain a certain amount of timber suitable for lumber, pulpwood and ties. The timber is composed of spruce, tamarack, white and black poplar and white birch.

Following are the dimensions and amounts of the timber on each ridge:—

Ridge No. 1.—Spruce suitable for lumber, diameter, ten inches; amount, eight hundred thousand feet. Tamarack suitable for ties, and piles, diameter seven inches; amount, one hundred thousand feet. Poplar suitable for pulpwood and building purposes, diameter, six inches; amount, five hundred thousand feet.

Ridge No. 2.—Spruce suitable for lumber, diameter, nine inches; amount, four hundred thousand feet. Tamarack suitable for ties and piles, diameter, nine inches;

amount, fifty thousand feet. Poplar suitable for pulpwood and building purposes, diameter, seven inches; amount, five hundred thousand feet.

Ridge No. 3.—Spruce suitable for lumber, diameter, twelve inches; amount, two million feet. Tamarack, suitable for ties and piles, diameter seven inches; amount, fifty thousand feet. Poplar suitable for pulpwood and building purposes, diameter, six inches; amount, fifty thousand feet.

Ridge No. 4.—Spruce suitable for lumber, diameter, twelve inches; amount, two million five hundred thousand feet. Tamarack suitable for ties and piles, diameter seven inches; amount three hundred thousand feet. Poplar suitable for pulpwood and building purposes, diameter, eight inches; amount one million feet.

Ridge No. 5.—Spruce suitable for lumber, diameter, ten inches ; amount, twenty thousand feet. Tamarack suitable for ties and piles, diameter, eight inches; amount, fifty thousand feet. Poplar suitable for pulpwood and building purposes, diameter, nine inches ; amount, forty thousand feet.

For the convenience of your department I have marked these ridges on the sketch map of the district, bracketing under each ridge the amount of timber contained on each.

The land like the first section that I explored is utterly unsuited for agricultural purposes. Muskegs, either of an open nature, or covered with three or four feet of moss form the prevailing feature. Scrub spruce and tamarack abound throughout it.

Small lakes, partaking more of the nature of sloughs are very numerous ; they contain no fish and the water in them is somewhat stagnant. Of streams, there are four between 'Twenty Mile' and 'Thirty Mile Stores.' Three of these rise in the Pasquia hills, two of them forming the head waters of Little Pasquia river. None of these streams are serviceable for lumbering or navigation as they are crooked, shallow and full of rapids. Their depth in summer runs from eighteen inches to two feet. The banks are alternately high and low, sometimes rising as high as three feet above and at others sinking almost to a level with the water. All these streams flow to the east, the average rate of their currents being about two and one-half miles an hour. Their width from bank to bank is at the most sixteen feet. The beds are a mixture of shale and gravel.

What timber there is, in the district, lies within easy access of the railroad, none of it being more than ten miles distant from the Hudson Bay railway. Owing, however, to the impossibility of driving the logs down the waterways, which in addition to their shallowness, flow the wrong way for the purposes of transportation, it would be necessary to draw the logs out in winter, unless the alternative plan was adopted of erecting a portable mill on the limits and thus saving the carrying of much waste material to the railway.

Little Pasquia river is the most important river in this section. In summer, like all the other streams it is very shallow and crooked. Rapids are numerous and the current very swift. It is, however, perfectly suitable for lumbering purposes, as in the spring of the year the water is amply deep enough for driving timber. The rapidity with which the river fills up may be judged from the fact that after a heavy rainfall in September, its depth increased twenty-two inches, with the result that a large portion of the country around its mouth was badly flooded. The width of the river is about forty feet. Dams cannot be erected anywhere along its course owing to the lowness of its banks.

The quality and quantity of the timber which adorns both banks of Little Pasquia river constitute its most important features. Whilst there are only two narrow fringes of timber varying in width from one hundred to two hundred feet, these extend from twenty-five to thirty miles up both sides of the stream and contain altogether about five million feet of good marketable spruce, tamarack, and poplar. The tamarack in comparison with the other woods, is scattered, but all the timber is of excellent quality and not to be excelled in any other part of this region. The spruce averages from ten to twelve inches in diameter, the tamarack about eight inches, and the poplar about the same. In one particular spot on the east side of the river there is a large patch of white poplar, covering an area of nearly four square miles which is really of magnificent quality. The timber along both banks of Little Pasquia river is very scattered, which will account for the small estimate I have placed on that particular area. The tamarack is mostly suitable for ties with a six inch face, or for piles. I estimate its amount at two hundred thousand feet. In addition there are about one million feet of poplar, suitable for pulpwood or for building purposes. On the west side of Little Pasquia river I discovered that a large section of land had been burned over, utterly destroying all the timber that had been upon it. There is along both banks, however, a considerable quantity of fallen timber, which is dry and sound and admirably fitted for firewood.

The country lying to the east and north of Little Pasquia is composed entirely of muskeg and is covered with spruce and tamarack scrub. There are no open muskegs and the only place where hay can be obtained is on either bank within a short distance of the river. The character of the country can be best judged from the fact that for days together we were compelled to wade in water to our knees. A unique feature of all the region that I traversed is that good timber is to be found only on ridges such as I have already mentioned. In this particular section there are no ridges whatever.

There are one or two small and insignificant lakes which scarcely merit mention. The streams which run into Little Pasquia river from the east are shallow, crooked and narrow, and are merely so many rivulets taking off the surplus water of the muskegs.

The same species of game which I have mentioned as abounding in the other sections are also to be found here in large numbers. Otter and mink haunt all the streams.

The nature of the climate is hard to determine as I was, of course, only in the country during the summer months. I noted, however, that there was an exceptionally heavy rainfall. The heat was intense during August and September, but there was hardly a night during the entire period that we did not experience a few degrees of frost. After a heavy rainfall, about August 20, there was a frost so severe that it froze the edges of the lakes and streams. By the end of September the grass on the muskegs was frozen so badly that it was neither palatable nor nutritious for our animals.

It was not included in my instructions to make any report on the village of The Pas. For the information of your department, however, I made inquiries of Mr. Edwards, who is in charge of the Church of England mission at that point, and gleaned from him the following facts regarding it. The population is about five hundred, including Indians. Most of the inhabitants are members of the Church of England. The village consists of a few half-breed houses, two stores and the Church of England mission. The church is a frame building and holds a congregation of one hundred and fifty. There is a resident doctor.

The Canadian Northern railway to Hudson bay runs through a muskeg country nearly the whole way from Etoimami to The Pas, a distance of eighty-nine miles. The engineers discovered that the muskeg of this particular section rested on a solid foundation of limestone gravel from between three to six feet below the surface and they claim that once the muskeg is drained a good roadbed will be obtained. I need not, therefore, dwell on the desirability of any other route for the Hudson Bay railway.

I am glad to report, in regard to the health of my party that not half an hour's illness was experienced by any one of us during the entire trip.

We were unfortunate enough to lose one of our horses during the early part of our work. The hard travelling and scarcity of feed being apparently the cause of its death.

We concluded our work on October 26, having worked back from Little Pasquia river to Etoimami. We were compelled to wait at Etoimami till Tuesday, October

30, owing to the lack of a car for our horses. On October 30, I shipped the horses in charge of one of my men to Prince Albert, the rest of us following by the first passenger train early on Thursday morning. We arrived in Prince Albert on the same evening. I paid one man off on Saturday, November 3, as soon as I received a telegram from your department to disband the party, but kept one on to take charge of the horses till the sale which took place on Monday, November 5. Under separate covers I have forwarded the bill of sale of our horses and outfit together with a statement of my accounts. I have also forwarded a copy of my diary covering the whole of our itinerary.

Trusting that the report will meet with your approval.

I have the honour to be, sir,

Your obedient servant,

A. D. MOODIE.

APPENDIX No. 33.

REPORT OF W. F. O'HARA, D.L.S.

SURVEYS AND RESURVEYS IN CENTRAL AND SOUTHERN ALBERTA.

OTTAWA, ONT., March 25, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour in accordance with my instructions, to submit the following general report upon my surveys of the season of 1906.

I left Ottawa early in the month of May, for the province of Alberta, taking the main line of the Canadian Pacific railway.

On May 12 I arrived at Calgary where I remained for a day or two, purchasing part of my outfit, and hiring part of my party. I then proceeded by rail to Lacombe where I hired the rest of my party, and completed the purchase of my outfit and supplies.

Until May 15 little or no rain fell, and the whole country was as dry as match wood. Many farmers were fearing a dry year, which would have been very disastrous to the country, but on the morning of the 15th rain began, and the sun was scarcely seen until the 31st, when the weather cleared. The wind blew from the northeast during that period, which is the rainy quarter in the province of Alberta. The whole country was flooded and the roads were impassable for some time.

In consequence of the state of the roads, I chartered a car from the railway company to move my outfit and supplies, from Lacombe to Nevis, about forty miles east. By this means I was enabled to get within about twenty miles of the scene of my field operations. The roads and trails at this distance from the railway were in much better condition than those nearer the settlements, and were passable. I then proceeded southerly by the roads and trails, to township 34, range 21, west of the fourth meridian, where I commenced my season's work. It consisted in this locality of correction surveys, which were not originally executed with the degree of precision required by the department.

I arrived here on June 6, and remained until September 17, making the necessary corrections in townships 32, 33, 34 and 35, range 21, and townships 32, 33 and 34, range 22, all west of the fourth meridian.

The land in this region consists of black loam from two to six inches deep, with a clay subsoil, and is well adapted for farming.

I then proceeded to Cygnet lake, about eight or ten miles west of Red Deer, in township 38, range 28, west of the fourth meridian, and township 38, range 1, west of the fifth meridian, the latter line passing nearly through the centre of the lake. I made a complete traverse of this body of water, also of the old shore line, the waters having receded, and produced the subdivision lines of the townships across those portions of the lake which had dried up. This work was required in consequence of applications having been made for lands, which the latest plans showed were entirely covered with water. This is a well timbered region, with poplar up to twelve inches in diameter. The soil consists of rich black loam from six to twelve inches, with a clay subsoil. The country is well settled, and the land is nearly all taken up and improved. The farmers all seem to be in a prosperous condition, judging from their fine buildings, good crops and large herds of cattle. I completed everything that was required here on October 8, and left for Red Deer on the 9th, arriving there about noon of the same day. On the 12th, I chartered a car from the Canadian Pacific railway, and shipped my entire outfit to Macleod, in the southern part of Alberta, arriving there on the 13th. On the 16th, I drove to Pincher Creek, a small town about twenty-seven miles southwest of Macleod.

I spent a day in reorganizing and purchasing supplies, and left on October 18, arriving at township 5, range 3, west of the fifth meridian, about four o'clock in the afternoon of the same day. On the day following fourteen inches of snow fell, the first severe storm of the season in this part of the province. My work consisted here of the subdivision of the township. The weather was so severe and storms so frequent, that I succeeded in surveying only a few miles. The country is heavily timbered with fir, pine and spruce, and differences of altitude of from 1,000 to 2,500 feet make surveying operations not only difficult but exceedingly slow. There is evidence of the presence of coal and petroleum in this township ; operations for the latter are now in progress. I remained here until November 28, and returned to Pincher Creek upon that date. I discharged my party, sold my outfit, and returned to Ottawa, arriving here on December 5.

I have the honour to be, sir,
Your obedient servant,
W. F. O'HARA, *D.L.S.*

APPENDIX No. 34.

REPORT OF A. W. PONTON, D.L.S.

SURVEYS IN NORTHERN ALBERTA.

MACLEOD, ALBERTA, November 3, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report of my survey of block outlines and base lines in the Lac LaBiche and Athabaska districts, under your instructions of November 20, 1905.

Leaving Macleod on January 6, 1906, I proceeded to Edmonton, where a party was organized, supplies and outfit purchased, and arrangements made to have outfit and supplies freighted to Lac LaBiche. My transport equipment, turned over to me by Mr. P. R. A. Belanger, inspector of surveys, consisted of one team of fair sized horses, and ten pack ponies, with proper equipment of saddles, &c.

Starting from Edmonton on January 13, I reached Duck lake near the point where my work commenced on the 21st. Owing to lack of good sleighing, it was found necessary to follow the ice road on the Saskatchewan to a point fifteen miles below Victoria, and from there to strike the Lac LaBiche road at Redclay creek.

Work was commenced on January 23, and until May 21, when I closed on the fifth meridian, weather conditions proved favourable, and no untoward circumstances occurred to interrupt the ordinary daily routine,—consequently good progress was made.

Owing to the light snow fall, and a period of intense cold which occurred in the early winter, frost penetrated the ground to an unusual depth for wooded country, and it was soon discovered that mounding could be done only at excessive cost and would also delay the projection of lines. I therefore decided to leave the mounding until the projection of lines was completed, and then, with a reduced party, mound back to my starting point. This plan was also rendered necessary by the small number of pack-ponies at my disposal being inadequate for the transportation of a party of the usual number of men. As it turned out this plan proved in the end the best that could have been followed, the mounds being constructed at less cost, and more strictly in accordance with regulations than would have been possible with frost in the ground.

Mounding back commenced on May 22, and the starting point of my survey, at the northeast corner of township 64, range 13, west of the fourth meridian, was reached on June 18. Between June 19 and 25 I returned by way of Victoria to Edmonton, where my party was paid off, and all government property in my possession handed over to Mr. P. R. A. Belanger, inspector of surveys.

Following is a description of the country through which I passed :—

The country in the neighbourhood of Lac LaBiche is generally wooded, poplar being found on the high land, and spruce in the swamps. The spruce timber available is sufficient to supply all lumber required for early settlement, but is too scattered for commercial purposes. A portable sawmill would best meet local requirements. The soil is generally a good clay loam, which becomes lighter and more of a sandy loam, as the lake shore is approached. Cut banks were observed at different points on the lake shore, showing clay loam forty feet in depth without stone. Small scattered areas have been partly cleared by fire, and these clearings will eventually facilitate settlement. Country of this description has been much favoured by Russian and other foreign settlers during recent years. Whitefish and ground game will provide the poorer class of settlers with a plentiful supply of food during the initial period of making a farm. Lac LaBiche as seen during the winter months is impressive, and its attractiveness during the summer must eventually lead to its becoming a popular pleasure resort.

The country lying between the lake and the fifth meridian is not attractive, and settlement will be slow. Lac LaBiche river offers some good land along its banks, but as it is not navigable, access is difficult.

(Note.—Descriptions of the townships surveyed have been taken from this report and published as part of Appendix No. 46.)

No trace of minerals of economic value were observed in the country passed over and rock in place seems entirely absent. Game, while not numerous, is still sufficient to assist the Indian and half-breed hunters through the winter. Lynx, as well as rabbits, were especially numerous. Partridge and prairie chicken were seldom seen. Between the Athabaska river and the fifth meridian signs of moose were very frequent, and for the past several years they have been numerous in the vicinity. No water-powers were observed, but Lac LaBiche river might furnish power if the water supply is sufficient at all seasons.

The winter climate in the neighbourhood of Lac LaBiche and Athabaska Landing appears to be similar to Edmonton, and although periods of low temperature occur, their duration seldom extends beyond a week. Good dry wood fuel abounds and cold weather causes little inconvenience to residents or travellers.

I have the honour to be, sir,

Your obedient servant,

A. W. PONTON, *D.L.S.*

APPENDIX No. 35.

REPORT OF W. R. REILLY, D.L.S.

RESURVEYS IN SASKATCHEWAN.

REGINA, SASK., February 27, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I have the honour to submit the following general report concerning my survey operations in the field from May 21, 1906, until February 5, 1907, according to your instructions dated at Ottawa, April 21, 1906, and subsequent instructions.

Your instructions were for me to take the transport outfit stored with Mr. Chas. H. Seymour near Saskatoon. On receiving your instructions I wrote Mr. Seymour in reference to the condition of the horses and other information about the outfit. I did not get an answer to my letter (which was some months after, returned to me through the dead letter office). After waiting several days I sent a man to Saskatoon to look up the outfit but no trace of Mr. Seymour could be found until I wired you and got the location of Mr. Seymour's homestead which was over thirty miles from Saskatoon.

I wired the man I had sent to Saskatoon to hire a livery and drive out after the outfit. On receiving word that they had arrived in Saskatoon, I left Regina on May 21. On the following day I organized my party and procured my supplies in Saskatoon.

The work throughout the season was either retracements or resurveys of townships that had been surveyed in the early eighties and have been reported on by the surveyor of each township. At the time of the original surveys the land was in the virgin state and far removed from the likelihood of immediate settlement. Its productiveness was then conjectured not demonstrated. It did not then present to the surveyor the same appearance as it now would, for settlement has changed the blank aspect of the country and cultivation has shown that excellent crops can be grown in favourable seasons, not only on first-class land but on ground that has been considered to be low grade.

As the country becomes more thickly settled the tendency is to take up the poorer class of homesteads. This is not often done by parties who pretend to make homes of them, but more by those who have purchased adjoining land, by whom a quarter is considered poor indeed if it is not worth homesteading.

The horses had wintered fairly well, but they were not in a condition to stand much driving until they had improved. So I decided to spare them, and began work in township 35, range 6, west of the third meridian, the nearest work to Saskatoon. In this township I could do but little driving on account of the river and scrub on the lines. By the time I had completed the township the horses were in good condition.

I moved into this township on May 23. The weather then was warm and bright, grass growing rapidly, trees budding, seeding well advanced, trails in good condition and the country presenting a fine appearance for the season.

I made a retracement and restoration survey of the outlines and interior meridians of this township, and a traverse of South Saskatchewan river in the southeast quarter of the township, which cuts sections 4, 3, 2, 10, 11, 12 and 1.

I found the majority of the old markings but many of the iron section corner posts were missing, and those found were in bad condition and not fit to be used. The wooden posts in the quarter section corners were nearly all destroyed. Mounds in most cases were unmistakable when found, but owing to the uneven surface of the ground, scrub on the lines and all traces of old lines being blotted out by fires and new growth, it was only by re-running the lines that a large number of these could be found. In the retracement of lines in this township and all retracements during the season's work, I resorted to random lines as being the most practical and expeditious way of carrying on the work.

The surface soil and general character of this township is varied. The southeast and northeast corners of the township are broken by the south branch of Saskatchewan river, which enters in and runs through sections 3, 10, 11, 1 and out in section 12, entering in again and running through section 36.

The east part of the township is flat, the west part from rolling to hilly, the division is marked by a range of hills skirting the flat from the southeast corner of section 5 to the northwest corner of section 35. Moon lake, a shallow body of fresh water, cuts sections 10, 14, 15, 16, 21, 22 and 23. It has low marshy shores with reeds extending far out into the water. It is considerably higher than the river into which it could be easily drained.

Generally speaking, a large portion of the southeast quarter of the township and the sections along the river are covered with a dense growth of red willow, poplar and balm of Gilead. The willow is large enough for fence posts, the poplar and balm of Gilead for fuel and rough buildings. The remainder of the township is dotted more or less with clumps of poplar and brush, but in few cases is there anything larger than six to eight inches in diameter. The soil of the flats is mostly a good clay loam. The upland in the northwest quarter of the township is a good sand loam running into light sand in the southwest quarter.

Nearly all the homesteads in the north half of the township are taken up, and some odd quarters have been bought up in the flats. It is but recently that the land has been settled on, but excellent progress has been made. Crops were looking well and gave promise of a good harvest. The greater part of the land is best adapted to mixed farming. The southwest quarter of the township is light, but excellent for grazing. Frequent rains occurred during the survey and the climate was all that could be desired.

I finished the survey of the lines on June 26 and started for townships 33 and 34, ranges 1 and 2, west of the third meridian, a block of four prairie townships.

I crossed the river at Saskatoon, where half a day was spent in procuring supplies and ferrying across the river. I arrived in township 34, range 2, at noon on June 28.

My instructions were to make a retracement and restoration survey of these townships. This work I proceeded with in township 34, range 2, until July 6. The original subdivision was very poor, consequently lines were very crooked and distances unequal. A local improvement district had been formed out of these four townships. It seems that for some time previous to the beginning of the survey the matter of a correction survey for these townships had been discussed in council and throughout the district. So when it was found that I was not making a new survey, only establishing old corners, general dissatisfaction seemed to prevail. A meeting of the council was called and you were wired concerning the disapproval of the survey. I wired you briefly the situation and received conditional instructions to make a resurvey of these townships, particulars of which have been sent to you in subsequent correspondence.

I made a retracement of the east boundary of townships 33 and 34, range 1, the east boundary of township 33, range 3, the north boundary of township 32, ranges 1 and 2, and a resurvey of all other outlines, interior meridians and cross lines in these four townships, destroying all old monuments. A traverse was made of all water areas. Many minor changes were made in the positions of the monuments and some gross errors corrected, the greatest being in township 33, range 2, where all the monuments (south of the lake in sections 19 and 20) on the east boundaries of sections 6, 7, 18 and 19 were over 13 chains in error. The positions of all old monuments are marked in the field notes, which will give in detail the changes made at every corner.

The general features of each township are similar. The surface is prairie, mostly rolling, parts hilly, all more or less cut with small lakes, ponds and grass sloughs, the water mostly alkaline. Excellent well water is got in many places by digging from 20 to 30 feet. The soil is generally a light clay loam running into sand loam in many places, and mostly alkaline in the low ground.

The district is new, being settled only about three years, but it has all the appearances of a much older settled country in regard to cultivation. A large amount of breaking has been done and considerable land is under crop, mostly wheat with a large proportion of oats and a small amount of barley. All presented an excellent appearance while growing and promised a large yield per acre. Some slight damage was done by hail. Hay is not plentiful, but a considerable quantity can be cut around many of the sloughs and in some places on the upland.

The surveyed line of the Grand Trunk Pacific railway running westward, enters township 33, range 1, at the quarter on the east boundary of section 36, crossing township 34, range 1, diagonally in a straight line, which is continued into section 33, township 34, range 2, where a slight deflection is made to the south. It leaves this township in the southwest quarter of section 31. A side track has been laid out on section 28, where a station is likely to be built. The building of this road has added fresh impetus to the district. Land has advanced rapidly and a large number of good buildings have been built this season. A number of good school houses, which are also used for church purposes, were built before I began the survey, township 34, range 2, having two, township 33, range 2, having one, and township 33, range 1, having two. There is a nice small Roman Catholic church in township 34, range 1.

The season for farming was exceptional, with abundance of rain, which produced both crops and grass, with no frost, much sunshine, little damage by hail and fair harvest weather. From present indications grain growing will for some time be the chief industry, but the district is well adapted for mixed farming, as grain, cattle, hogs and horses, all do exceptionally well. Such class of farming is the best kind of insurance against the uncertainties of farming in this country.

In the retracement of the base lines across ranges 1 and 2 and the third meridian on the east boundaries of townships 33 and 34, I found the lines straight and the chaining excellent, especially on the base where our chaining scarcely varied a link to the mile. This is so different from the subdivision work done in these townships that it shows that not even ordinary care was taken with the work.

On August 25 I finished the traverse of lakes in township 34, range 2, which completed the survey in this district. On the same day I received your instructions dated August 16 to examine and report on the necessity of a survey of township 34, range 6, west of the third meridian. On August 27 I took one man with me and drove into this township by way of Saskatoon and made an examination which was reported to you at the time. In the meantime my outfit moved into township 37, range 1, west of the third meridian.

Township 37, range 1 and townships 38, ranges 1, 2 and 3, west of the third meridian formed the next district surveyed. I made a retracement and restoration survey of the outlines and interior meridians in these four townships, also a traverse of a number of water areas, which differed materially from the original surveys. These townships are open prairie. Many minor errors were found. The survey was perhaps honestly done and was a superior class of work to what was done in townships 33 and 34, ranges 1 and 2. I found nearly all orginal markings but the majority of them were nearly blotted out. Townships 37 and 38, range 1 and township 38, range 2, were posted with wooden posts which were nearly all destroyed. Township 38, range 3 was posted with iron posts, but few were found.

Township 37, range 1, is very hilly on the south and west sides rolling to hilly on the east and north sides, depressed in the interior and much broken by water areas.

In township 38, range 1, the two tiers of sections on the north side are almost flat, the balance of township is rolling to hilly, with several water areas.

Township 38, range 2 is cut diagonally by a range of hills from section 6 to 36, the northwest part is rolling, the southeast part hilly and stony.

Township 38, range 3 is rolling and stony in the northwest corner. The greater part of this township, the rolling and the flat land in townships 38, ranges 1 and 2 and a number of quarter sections in township 37, range 1, are first-class farming lands. The soil is either a rich sand or clay loam and produces good crops. The soil of the hilly ground is good but it is best adapted for grazing. Where it is stony, it is fitted for little else. Water is plentiful, mostly fresh. Hay is rather scarce but a limited quantity can be cut in each township.

The main line of the Canadian Northern railway just skirts the north boundary of township 38. The town of Vonda is in range 1, Aberdeen in range 3, with elevators at each place. The settlement is new but developing fast. Wheat is the principal crop.

I finished the survey of these townships on October 16. The mounders had several lines to do, so I put all hands at mounding and I took advantage of the time to investigate an error on the east boundary of section 34, township 31, range 9, west of the third meridian, according to your instructions dated August 27. The particulars have been reported to you. The mounding was finished the day I returned to camp, October 23.

On the following day I started north for the next work in townships 41 and 42, ranges 27 and 28 west of the second meridian, camping on the ground in township 41, range 28, on the 25th.

I made a retracement and restoration survey of the outlines and interior meridians in townships 41 and 42, range 28, and a retracement of the outlines and interior meridians in townships 41 and 42, range 27. The mounding of these two townships as before reported is not done.

These townships are much different from the prairie country to the south. The surface is from rolling to hilly more or less broken by hills and water areas and dotted with clumps or large stretches of poplar. Water is plentiful but more or less alkaline. The soil is very good in the greater part of the township. With very few exceptions this district is settled with Galicians. Nearly every homestead has been taken up in these townships and more or less improved. A number have quite large areas in crop and threshed a thousand bushels of wheat this season. The settlement is new but good progress is being made. The dwellings put up by these people are substantial and warm. They are built of logs, one story high, with thatched roof; the walls are plastered over inside and out with clay and then whitewashed. A flour mill and store in township 42, range 26, is more or less patronized. The greater amount of trading is done in Rosthern, on the Prince Albert branch, and Vonda on the main line of the Canadian Northern railway.

The weather during the progress of the work was fine for the season. The ground froze up about November 20. The first snow of the season, a light flurry, fell on November 1. The snow fall was light until Christmas, when a heavy storm increased the depth to 14 inches.

I finished the work in this district on December 29. On the following Monday I started by way of Vonda, Aberdeen and Saskatoon for township 34, range 6, west of the third meridian, to make a retracement of the lines in this township according to your instructions dated September 13, 1906. Owing to unbroken roads, heavy snow drifts and extremely cold weather it took one week to make the trip and get camped in this township. The outlines on the east and the west sides and the interior meridians next these outlines are on hilly prairie. Heavy snow drifts made it impossible to locate mounds on these lines. The three meridian lines in the centre of the township could not be run with satisfaction except when frozen up. I found original corners from which I located the corners on the north boundary of townships 33 and 34, governing these lines. I surveyed these lines and the cross lines connecting them, planting all quarter and corner posts but no mounds were built. I traversed a body of fresh water in sections 4, 5, 8, 17 and 16, known as Pike lake, also both banks of the river and the islands in it. Extra heavy cutting was done through willow jungles on these lines. All lines not run being on high ground can be run best in summer time when markings can be found if they exist. From the many discrepancies shown on the plan and the absence of all markings or old cuttings I do not think these centre lines were run in the original subdivision.

A description is given in the field books for each township surveyed during the season.

Searching for old markings and noting their positions made the work much slower than running original lines. During the season's work seven hundred miles of section lines were run and over one hundred miles of traverse work. Nearly one hundred miles of lines were heavy cutting.

I quit work February 2, arriving in Saskatoon with my party on the 4th. I paid off the men the following day. The horses were let out for winter with Mr. T. W. McNeil, on section 14, township 33, range 6, west of the third meridian. Transport goods were stored with J. F. Cairns, Esq., Saskatoon.

The railroad being blocked, I was delayed in reaching home until Saturday, February 9.

I have the honour to be, sir,
Your obedient servant,
WM. R. REILLY, *D.L.S.*

APPENDIX No. 36.

REPORT OF J. F. RICHARDS, D.L.S.

SURVEYS IN NORTHEASTERN SASKATCHEWAN AND NORTHWESTERN KEEWATIN.

STE ANNE DE LA POCATIERE, March 18, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report of the surveys made by me during the last session at Cumberland House, at The Pas and at Big Eddy, following your instructions (file No. 627210), dated May 11 and those following dated August 3 and 30 last.

I left Ottawa on June 8 for Cumberland House and reached Winnipegosis on the 12th, which place I left the same day by the N.W. Fish company's boat for High Portage on Cedar lake, arriving there on the evening of June 13.

On June 16 I took the *Cumberland*, one of the N.W. Fish company's boats, for Cumberland House, arriving there on June 18.

Cumberland House is situated on Cumberland island, which is a small island near the southeast bank of Cumberland lake, about six miles north of Saskatchewan river.

The commerce of Cumberland, especially in furs, is considerable. The Hudson's Bay company has an important post here, and Revillon & Co., has built and established stores there during the course of the summer. A school and a Catholic chapel are found there. The Catholic church and the residence of the Catholic missionaries are situated at the southeast corner of the Hudson's Bay company's reserve, quite near the south limit of the said reserve.

At about three-quarters of a mile farther on, towards the south, is the Indian reserve on which there is a school and a chapel under the direction of the Rev. Mr. Settee, Anglican missionary.

Cumberland, including the Indian reserve, has about 600 inhabitants, of which two-thirds at least, are of Indian origin. There are only a couple of white families there, the rest being English and French half-breeds, the English half-breeds predominating. The language generally spoken there is Cree, although several of the half-breeds understand English, and six or seven amongst them understand French. These half-breeds hunt, fish or work for the companies mentioned above.

In the event of hunting and fishing coming to an end or decreasing sensibly, this population would suffer the greatest privations. The price of merchandise of all kinds is excessively high.

The abuse of alcoholic liquors makes sad ravages here, in spite of the efforts of the Catholic missionaries, and those of other religious denominations who combat this curse.

These half-breeds are generally hospitable, very intelligent, of an independent character, very pacific and very honest, but improvident, troubling little about the future, and living only from day to day. They have a repugnance to ordinary manual labour, especially to agricultural work. They are excellent hunters, good fishers, and good guides. Their power of endurance is remarkable, as shown in the long and difficult trips which they have to take in canoes, on foot or with dogs, according to circumstances.

The land in the neighbourhood of Cumberland House, that of the Hudson's Bay company excepted, is damp, swampy and of little use for farming. The small extent of arable land which is met there is moreover very rocky and very difficult to improve. The inundations of Cumberland lake and of Saskatchewan river are sometimes so great and the country is in general so flat, that cattle raising would have little chance of success.

There are no stone quarries, nor is there any water-power there. There is wood everywhere, chiefly pine and poplar, with some birch, but it is too small for lumbering.

Apart from those made on the Hudson's Bay company's reserve, the clearings are of very little importance. None of the clearings are more than fifteen acres in extent, and not more than one-quarter of this is well cultivated.

The summer is short, but hot, and the vegetation is extraordinarily vigorous and rapid. Potatoes and vegetables of all kinds grow and ripen well. It is claimed that it would be the same for barley, oats and even wheat.

The last frosts come in June and the first in September. Winter commences about November 1, and spring towards April.

Fish abound, especially sturgeon and whitefish. Wild duck and bustard are found most plentifully, but the stag, elk, bear, otter, bison, muskrat and marten all abound.

Almost all the land occupied by the half-breeds is covered with wood, in the midst of which their houses are found here and there and sometimes very near to each other. It took some time to settle the position of the houses and to determine the general arrangement of the lots.

As the original limits of the Hudson's Bay company's reserve have been obliterated or lost, re-establishment has become necessary to settle the front of the half-breeds' lots. The road which I surveyed to lead to the Catholic mission at Bigstone river is not exactly in the same place as that mentioned in the order-in-council accompanying my instructions, because this latter road for the most part, passes on the Hudson's Bay company's reserve.

In order to leave, in as far as possible, the half-breeds or others, in possession of the land which they occupy, I have been obliged to make lots irregular and of different areas.

It was only after several conferences and minute explanations that they understood what it was a question of doing, and that I was able to adopt the method which gave them the most satisfaction. I have settled thirty-seven lots which, except three or four, were already occupied or claimed.

I have retraced the limits of this portion of the Indian reserve granted by the Department of Indian Affairs. The southern boundary of this portion has a length of 80·80 chains. Its western boundary is 78·90 chains. I have taken the bearings of Cumberland lake from the east extremity of the southern boundary of the Indian reserve to the southern boundary of the Hudson's Bay company's reserve, then the bearings of Bigstone river from the western boundary of the Hudson's Bay company's reserve to the western boundary of the Indian reserve. The sketch attached shows all the surveys.

I finished the work at Cumberland August 3. On Monday August 6, I left Cumberland for the Pas on one of the Hudson's Bay company's boats, where I arrived in the afternoon of the same day.

On arriving at The Pas I met Mr. Wickham, Mr. Finger's agent, with whom I immediately visited the places to be surveyed, accompanied by Father Boisson, Oblate missionary, and Dr. Larose, as interpreters, and by some of the half-breeds who occupied land adjacent to that which Mr. Finger wished to obtain.

It was decided between Mr. Wickham and myself, that the work of surveying should begin the morning of the next day, but I could not proceed to survey before the 8th, *i.e.*, Wednesday, seeing that the day before Mr. Wickham had not been able, he said, to find any person to help me. The 8th, 9th, 10th and 11th of August were employed in surveying the land of Mr. Finger and the lands of the half-breeds, which were adjacent to his. I was helped by three men only, as Mr. Wickman claimed that he could not find more. Sunday, August 12 I took advantage of a boat which left The Pas for High portage, where we arrived in the afternoon of the 14th, after a very stormy voyage on Cedar lake.

On the evening ofAugust 15 I took one of the Northwest Fish company's boats for Winnipegosis, where we arrived about noon on the 16th. There I found your instructions addressed to me at the post office, dated August 3, ordering me to return to The Pas if I had left there, in order to make a settlement survey at Big eddy. The next day, the 17th, I left Winnipegosis for The Pas, where I arrived on the evening of the 23rd.

On August 25 I met one of the half-breeds from Big eddy named Henry Cook, at The Pas, who had come at my express request to confer with me about the settlement, which could be made at Big eddy. Mr. Cook represented the half-breeds at Big eddy.

The Big eddy settlement is situated to the north of Saskatchewan river on the back line of The Pas Indian reserve. It is therefore separated from Saskatchewan river by the Indian reserve. It is the only place at Big eddy, outside of the Indian reserve, where it is possible to build houses on land which is somewhat dry and beyond the reach of floods. I have surveyed at Big eddy eighteen regular lots each two chains in length and having an area of two acres. Sixteen half-breeds each claim one of these lots. No improvements of any consequence have been made on any of these lots, except on lot 14, where there is the beginning of a house.

I have also taken the bearings of a part of the point named Big eddy point, which is opposite the settlement on the south side of Saskatchewan river. On September 8 in the forenoon, several of the Big eddy half-breeds came to meet me, and again begged urgently for the survey of Big eddy point.

The part of this point comprised betwen the red line 10 and 14 on the attached sketch and Saskatchewan river is claimed by these half-breeds, that is, they desire to have the use of it gratis, as land for hay. Naturally I have not been able to guarantee them either the ownership or the use with a free title of this point. I have surveyed it so as to make their claims known to the department. Henry Cook and some other half-breeds have already occupied this point. There are still three houses to be seen, which they built formerly there and which they had to abandon a few years ago on account of the floods from Saskatchewan river. They place great hopes in this point and cannot believe that it can be refused them. They also wish to have a free title as proprietors of the settlement lots.

It can be said that there is practically no cultivable land at Big eddy.

The general observations made about Cumberland apply here. However, alcoholic liquors, so en vogue down there are used only very little or not at all here.

I finished the survey of Big eddy on September 19, and went to The Pas the same day, which is four miles to the east. I immediately commenced the survey of the settlement of The Pas.

The settlement of The Pas is situated on the south bank of Saskatchewan river. It is bounded on the east by that part of the Indian reserve, designated under the name of block B, and on the west by that other part of The Pas Indian reserve, designated under the name of block A.

I made ten lots there. Lots 1 to 6, inclusive are occupied and claimed by the half-breeds. Lots 7 to 10, inclusive, are vacant or rather are those which Mr. Finger could obtain without any person having anything to complain about.

Except a few little pieces here and there on the bank of Saskatchewan river, all these lots are practically unfit for cultivation unless extensive draining operations are carried on. The rest is a plain covered with a bed of moss from twelve to twenty-four inches in depth, appearing to extend towards the south beyond the settlement for some distance. This plain is moreover covered by a black or red pine timber from three to eight inches in diameter.

The half-breeds have made some improvements on their lots, but altogether they have only a very small area on each lot in a state of cultivation or as a garden.

The Pas half-breeds, like those of Big eddy, are almost all of English origin. The language spoken is Cree.

The population of The Pas, counting the Indians of the reserve, is about 500.

The means of subsistence are the same as at Cumberland.

The Pas is the seat of an Indian agency, of which Mr. Fisher has the direction. It is at The Pas that Dr. Larose lives, the physician named by the government for the care of the Indians. There is a school built and maintained by the government for the Indians.

Almost the whole population professes the Anglican religion which has as missionary the Rev. Mr. Edelbard. The Anglican chapel is a good sized building.

One of the branches of the Canadian Northern, a railway which runs towards Hudson bay, ought to reach The Pas during the course of the summer.

The Hudson's Bay company has an important post here under the direction of Mr. Shalcrosse.

I finished the settlement of The Pas on October 12. I next surveyed the lands of the Anglican mission, which I finished on October 23.

At this date the service of the Hudson's Bay company's boats as well as that of the N. W. Fish company had ceased, so it was impossible to return by the water route. I was obliged to wait for the winter roads, and it was not until November 22 that it was possible for me to leave The Pas. I made the distance which separated me from the railroad by a dog train.

I left Winnipeg on December 5, and reached Ottawa on the 8th, and again left on the 11th for Ste. Anne de la Pocatiere.

I contracted la grippe while coming from the Northwest, and after returning to my family I was unable to do any work whatever for over two months. I am now almost well and will finish my returns as soon as possible.

Hoping that you will be satisfied with this report which I respectfully submit to you.

I have the honour to be, sir,
Your obedient servant,

J. F. RICHARD. *D.L.S.*

APPENDIX No. 37.

REPORT OF JOS. E. ROSS, D.L.S.

SURVEYS IN RAILWAY BELT, KAMLOOPS DISTRICT, BRITISH COLUMBIA.

KAMLOOPS, B.C., March 23, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following general report on my surveys during the past season in the railway belt, British Columbia.

A year ago to-day I began the season's work by making two small surveys along the line of the Canadian Pacific railway, one near Ashcroft, the other opposite Spatsum. At the first place there is a little cultivable bench land which would need to be irrigated. The soil, however, is of such an absorbent nature that when irrigated it has a tendency to cause slides. For this reason I understand the railway company objects to the lands adjacent to the track in this locality being irrigated. It has already been the cause of several very expensive lawsuits in which the company so far has been successful. At Spatsum the land surveyed is adapted only for grazing, being stony, hilly and broken. This land I understand was being taken up or applied for on account of the gypsum deposits on it. Some development work has been done but I did not make any examination of it.

My next work was the subdivision of the range lands on the hills immediately south of Kamloops. These lands are covered by grazing leases. It has been a matter of contention between the lessees and the settlers as to whether the land is fit for general farming or not. The general opinion appears to have been that the land was unsuited for farming otherwise it would have been taken up and settled on many years ago. Some fifty or sixty squatters have located here within the last two years. Time alone can tell how successful they will be. Probably a few will do well while others will abandon it. The conditions have been unfavourable. The last two summers have not only been dry but they have been preceded by winters with a very light snowfall. Last summer the grasshoppers did considerable damage to the crops. The country is mostly open but there is sufficient fuel for many years. In the gulches and low places there are poplar groves which furnish fencing material. The surface is undulating, gently rolling and hilly. The soil is rather light but fairly good around the base of the hills. The water is mostly alkaline. There are no mountain streams but numerous ponds and small lakes. Water for domestic purposes can generally be obtained by digging. There are also good springs. The altitude is from three thousand to four thousand feet above sea level. There are numerous prospects and mineral claims but so far only one proved to be a mine.

From the Kamloops range I went to Long lake where I subdivided the remaining unsurveyed lands. The character of these lands is precisely similar to those just described. The best of the land was surveyed and settled on quite a few years ago. From here I continued farther south to the belt boundary at Stump lake. I surveyed a few sections here along the boundary and west of the lake. This country is rougher, being rocky and broken and fit only for grazing. Several mineral claims have been located here. There are fairly good wagon roads leading from Kamloops to all the lands surveyed to the south. A climb, however, of about two thousand feet has always to be made.

I next went to the main valley of Sullivan creek on the east side of north Thompson river where I surveyed a few sections along the north limit of the belt and corrected or changed some of the old surveys which had been made before the present boundary had been decided on. This survey was made chiefly to meet the requirements of settlers who had located here recently. The country here is partly open and partly timbered. The bottom land of which there is but a small quantity has considerable brush on it. The high land requires to be irrigated. There is not sufficient water for this purpose unless the lakes at the head of the creek are drained. All the suitable land for farming has already been taken up. There is a good wagon road from Kamloops by way of Hefferly creek. There is an ascent of about fifteen hundred feet.

From here I came down to north Thompson valley where I spent some considerable time making surveys to fix the location of some old provincial lots so that the areas of the adjoining quarter sections might be found. This kind of survey involves a great deal more work than would be called for in making an original survey. It is often unsatisfactory as the old lines or corners can not be found and much of the work done seems to be to no purpose.

On completing the work here I went to Revelstoke where after making a small survey west of the town I proceeded to connect the right-of-way of the Arrow lake branch of the Canadian Pacific railway with the Dominion section lines. A little delay was occasioned here through not knowing the exact way in which the survey should be made. The weather, too, which had, so far, been fine turned wet and continued so for almost the remainder of the season.

From here I went south to the valley of Incomappleux river. From the boundary of the belt I made a sectional survey about six miles up the river. I also traversed both banks of the river. The valley is about three-quarters of a mile in width and has steep mountains on each side. On the mountain side the timber is medium sized hemlock, cedar and fir. On the higher lands in the valley there is some very large cedar. On the low lands the timber is spruce and cottonwood. The greater part of the valley is fit for settlement, and the climate is not unfavourable. The cost of clearing an acre of the best land would range from one hundred to two hundred dollars. Freshets occur in the river during spring and after a heavy rainfall of several days duration when low lying lands are flooded. The most valuable natural resources of this district are the timber and minerals. The timber is very conveniently situated to the river which is navigable for logs at certain stages of the water. Very rich mineral has been found here but most of the claims are high up on the mountains, and as transportation is by means of pack horses the cost of getting the ore out is too great to permit of the mines being worked at a profit. There are numerous small streams flowing into Incomappleux river, upon each of which there is some available water-power. Goat were seen on the mountain sides and marten, mink and weasel in the valley. The usual route to this district is by way of Revelstoke, thence by the branch line to Arrowhead, thence by steamboat to Beaton or Comaplix, thence by stage to Camborne; from the latter place there is a pack trail up the valley on each side of the river.

On my return to Kamloops I made several smoll surveys on Shuswap lake (two on Mara lake and one at Cinnemousun narrows). All these lands had been applied for. Years ago it was thought that all the land suitable for settlement in the railway belt had been surveyed and taken up but still the settlers continue to come and squat on land where the prospects of making a good living are not at all promising. I think it is the good climate rather than the land which induces people to come to British Columbia; this is especially the case where people come from the Northwest.

I have the honour to be, sir,

Your obedient servant,

JOS E. ROSS, *D.L.S.*

APPENDIX No. 38.

REPORT OF ARTHUR SAINT CYR, D.L.S.

SURVEYS OF BLOCK OUTLINES IN THE PEACE RIVER DISTRICT.

OTTAWA, March 15, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General.
Ottawa.

SIR,—I have the honour to submit the following general report of my surveys of block outlines in the Peace river district performed under your instructions, dated March 12, 1906.

I left Ottawa on March 13, and five days later arrived in Edmonton, where I stayed just long enough to organize my party, consisting of twelve men, and to arrange their transportation to Lesser Slave lake. The bulk of my supplies and outfit, ordered a month before, had already been shipped to its destination over the winter roads.

On March 23 I started for Athabaska Landing, where we arrived on the 26th. Here sleds were substituted for the wagons, and the next day we continued our trip over Athabaska river towards Lesser Slave lake.

No serious difficulties were met with on Slave river, though we frequently found the ice covered with a foot of water. In such places the ice was unsafe and it necessitated long detours. We pushed on with all diligence, trusting much to luck, but at five miles above Donaldson's ranch, which is at the confluence of the Moose and Slave rivers, the sled carrying my instruments suddenly broke through the ice. This is a particularly bad spot on the river, and is much feared by all freighters. The river here is very deep, and owing to many warm springs the ice is always more or less cut by air holes, and thus made unsafe. The great width of the rack which was bolted to the sleds, and which caught on the edge of the ice, prevented us all from going to the bottom. It also allowed us time to save the instruments and to recover most of the baggage which was afloat. However, we resumed our trip over the ice keeping close to the shore, but a few miles farther on we found the river clear of ice, and so we had to land. Here I got two wagons to take up most of our outfit, and with light loaded sleds we reached Johnny Stony's place on the left bank of the river.

From this point we followed the winter overland trail ,which runs across a couple of small lakes and some large swamps. It is the most direct route to the foot of Lesser Slave lake. In crossing the lake we were delayed by having to go around a large opening which generally forms at the lake narrows and which every year causes the loss of the loads and outfits of many freighters.

On April 2 we landed about three miles east of Stony point and reached the trading post of Revillon Bros. at Lesser Slave lake, the same night. Here I arranged with two freighters to take to Snipe lake part of the supplies required for completing the survey of the seventeenth and eighteenth base lines west of the fifth meridian. I had already forwarded baled hay and oats to that point which I intended to make my depot for this survey.

On April 9, having received from Revillon Bros., successors to Bredin & Cornwall, part of Mr. Wallace's packing outfit, which had been stored with them the previous fall, I crossed Buffalo bay and went to camp at Prairie River Settlement. In this vicinity the quality of the soil is all that could be desired for any kind of cultivation. Though recently opened, this section bids fair to become one of the most prosperous in the country. There is already a large acreage under cultivation, and the returns from the tilled land have exceeded all the expectations of the settlers. Moreover, they have no trouble in marketing their produce at high prices. Good hay in unlimited quantities can be cut in this vicinity and along the shore of Slave lake, so that it becomes an easy matter for farmers to keep cattle. This country is well watered by numerous running streams. Oats and barley had been successfully grown here for some years, but Mr. O. D. Hill was the first to try growing wheat. The experiment proved successful, and it is expected that wheat growing will become one of the chief occupations of the farmers. Up to the present all the flour used in this district has had to be brought from Edmonton or Morinville at very great expense. This is the land which, in 1905, I recommended to you for immediate survey, and I am glad that it is turning out so well.

A good wagon road connects Prairie River Settlement with that of Lesser Slave lake and also with the trading post and mission at Sturgeon lake which is situated about sixty-five miles to the southwest. On April 11 we left the settlement by the Sturgeon lake winter road, and soon came to an undulating country wooded with poplar, birch and spruce. At noon we forded West Prairie river. During the afternoon we continued our journey through the forest, and at night pitched our tents near a small lake lying about thirteen miles southwest of the settlement. The country around that lake is low and swampy. The next day we crossed the nineteenth base line in township 72, range 17. From there the land gradually rises and the road skirts along the southern slope.

Late in the afternoon we reached the east shore of Snipe lake, 1,800 feet above sea level. Here the freighters were paid off. Some of the men were now instructed to put up the supplies in seventy-five pound packages, while the rest were sent to cut a trail around the lake and build a cache near its south end. In this cache I intended to leave what supplies were not wanted for immediate use, and thus avoid in the future the trip around the north end of this lake.

On April 17 we travelled to the west side of Snipe lake and camped at the intersection of our newly cut pack trail with the Sturgeon lake winter road which is a continuation of the one followed by us since we left the settlement. West of Snipe lake all the timber has been burnt and with very little work the land which is good could be cleared of the willow and poplar scrub with which it is now covered. This flat country extends also north of Snipe lake. There it is covered with small birch and second growth poplar and a few spruce. It is drained by Snipe creek which empties into Little Smoky river less than a mile north of the point where the nineteenth base line intersects that stream. To the south it is bounded by a range of low hills which rise opposite the southern extremity of the lake and extend in a westerly direction. From the west shore of Snipe lake where we had established our depot we continued the work on the trail leading south towards the eighteenth base line, which is twelve miles distant. On April 19 we camped at a creek of running water, one-quarter of a mile east of the northeast corner of section 31, township 68, range 19, west of the fifth meridian, which was the initial point of my survey. The country travelled over between the south extremity of Snipe lake and the eighteenth base line is rolling and the land is timbered with poplar, spruce, balsam, fir and birch from six to twelve inches in diameter. The soil is a black loam from four to six inches deep with a clay subsoil. We crossed numerous small streams all flowing northwesterly, the principal one being Carrot creek which we crossed about four miles north of the line. It flows between high banks and empties into Little Smoky river joining it a mile and a half south of the point where the winter road comes down to the river. From the top of the hill which bounds the valley of Carrot creek on the south the land is flat and is densely wooded with spruce averaging six inches in diameter.

I began the survey of the eighteenth base line at the northeast corner of township 68, range 20. In this range the soil is principally clay with an alluvial deposit of black loam a few inches in depth. The surface is undulating and is timbered throughout with poplar, cottonwood, spruce, balsam, fir and birch. There is also an undergrowth of willow and alder which is very thick in places. All the different kinds of timber are well distributed as to size, running from six to twelve inches in diameter. Many small running streams, tributaries to Carrot creek, drain this part of the country. In section 35 we crossed the height of land (2,300 feet above sea level) between Carrot creek and Goose river.

In range 21 the base line crosses Goose river (altitude 1,900 feet above sea level) three times, once in the middle of section 34 and twice at short intervals near the northeast corner of section 33. This stream coming from the southeast flows also into Little Smoky river, joining it about two miles north of its intersection with the base line.

Goose river is two chains wide with banks ten to forty feet high. It flows swiftly over a stony bottom. A well defined pack trail intersecting the north boundary of this township near the northeast corner of section 33 leads to the confluence of Goose river with Little Smoky river. This is a favourite camping ground used by the Indian hunters from Sturgeon lake when journeying to the south on their frequent hunting expeditions.

Little Smoky river (1,700 feet above sea level) is the next and largest stream intersected by this line. It is met first in the middle of section 31 and again close to the northeast corner of township 68, range 22. At this crossing the river is three chains wide with a depth of three feet, at the time of survey. It has a sandy bottom and its banks are thirty feet high. Its valley is about half a mile wide. There is some partly open level land, at intervals along this stream and thin seams of coal were seen along its banks. The east half of this range is wooded with poplar, spruce and birch. The soil is the same as in the preceding range. The west half is in places swampy, and wooded with small spruce.

In range 22 Little Smoky river is crossed for the last time in the middle of section 36. From that point westerly to the northeast corner of township 68, range 23, the ground is gradually rising and undulating. In sections 35 and 34 the land is covered with young poplar and scrub willow and could be easily cleared. Sections 33 and 34 are generally swampy. Then poplar and spruce bush begins and extends to the west limit of this range which is as far as this survey went. The monument marking the northeast corner of township 68, range 23, as established by this survey, was erected. A line was also opened between that post and the one established by a previous survey and its length and bearing were recorded in the notes. The pack trail from lake St. Ann to Sturgeon lake crosses this line close to the northeast corner of township 68, range 23. The general elevation of this part of the country is 2,000 feet above sea level. The soil is good.

I now returned along the eighteenth base completing, on the way, some mounding which had been left undone on account of frost in the ground, and reached again our main cache at the northeast corner of township 68, range 20. From that point a trail had to be opened southerly towards the seventeenth base line, twenty-four miles distant.

The country between these base lines is also thickly wooded with poplar, spruce, cottonwood and birch while jackpine grows on the high land. Its surface is rolling or undulating. On May 21 we moved camp from the cache on the eighteenth base line, and after travelling one and a half miles came to a divide 2,200 feet above the sea. Shortly afterwards we crossed a good sized creek of fresh water, beyond which our trail ran across low and swampy lands, with many small hay meadows, and here I decided to camp over night. These meadows were the only ones noticed that day along the road. On the next day we had better travelling across a dry and park like country, sparsely wooded with small poplar, spruce and some jackpine, all probably of second growth. Then came a two-mile belt of spruce, some of them being fifteen inches in diameter. We were now approaching Goose river, which flows in a depression 200 feet below the general elevation (2,000 above sea level) of the surrounding country. Crossing one more creek we camped about ten chains west of the forks of the river. For a few days previous there had been heavy showers daily, frequently accompanied with hail. I was therefore not much surprised when, on descending towards the valley of this river, I found the ground still covered in spots with an inch or so of hail stones. The river was also so swollen that it was not safe to ford it with loaded pack animals. So I went to explore along the river banks for a suitable crossing. Shortly after leaving camp I came to the junction of two streams. The one from the southeast was the widest, but judging from the swiftness of the current it was also much shallower than the other branch, whose water flows through a deep channel cut between high steep banks. This last stream appears to come from the northeast and, according to the report of some Indians, it flows from a lake lying eight or ten miles from the forks. I went along this last stream for some distance, but, finding no fording place, I returned to camp and had a raft built on which we crossed the river and continued the work on the trail, leaving the ferrying of the outfit till the water should have somewhat subsided. For a distance of half a mile from that point we followed along the left bank of the river, which, however, soon got so steep and high that we had again to enter the woods. Here we had to make a detour to the west in order to avoid some muskegs which lie in the vicinity of the river.

Beyond these muskegs we came to sandy ridges wooded with jackpine, with more narrow swamps intervening. Shortly after, however, we struck a better country, with a gradual ascent towards the south. We crossed the summit (2,250 feet above sea level) four miles south of the river. For two miles more the country is nearly level. Then comes a strip of burnt country covered with windfall. These destructive fires were, however prevented from spreading east by extensive swamps and muskegs. From these swamps two good sized creeks rise and flow towards the west, where they eventually join the Iosegun river, which is a tributary to Little Smoky river. At three miles south of the summit we came to Atikkamek ('poisson blanc') creek, another deep stream across which we had to throw a bridge about one mile east of its confluence with Iosegun river. This last part of our journey had been made over very soft ground, which would have been impassable but for the fact that the subsoil was still frozen in many places. Across Atikkamek creek we found the old Lake St. Ann pack trail, which we followed easterly and which led us to the place where Mr. Driscoll had two years before cached his survey posts.

I began the survey of the seventeenth base, which is the north boundary of township 64, at the northeast corner of section 34, in range 19, and produced it westerly for three ranges and a half across a timbered country drained by many streams, chief among which are Little Smoky river and two of its affluents—Iosegun river from the east and Waskahigan river from the west. I believe that these rivers join Little Smoky river from opposite sides within a short distance of each other. Atikkamek creek, which I have already mentioned in describing the country between the seventeenth and the eighteenth bases, is the principal tributary of the Iosegun river. It comes from the northeast and, after intersecting the seventeenth base in range 18, flows along the south side of the line till, in section 34, range 19, it passes again to the north of it, and shortly afterwards joins Iosegun river. This creek rises in the same low country as Goose and West Prairie rivers. Only one lake, three miles long and one mile wide, was seen three-quarters of a mile north of range 20, but in this section, where so many muskegs occur, there are probably many others not seen from the line.

Exploratory trips made to the south of the line showed that the land there is also low and swampy. I was informed by my packers, who followed the pack trail along Iosegun river when going to Sturgeon lake for mail and supplies, that in that direction they found travel most difficult from the same cause. This also coincides with the reports from the Indians, who frequently visit this country on their hunting excursions. Some open prairie patches were seen, but only in occasional flats along Waskahigan river, More prairie land may, however, exist along the lower reach of this stream, whose valley seems to widen as it approaches that of Little Smoky river. The soil in these flats is good, though light. This was the best land and the easiest to clear and cultivate that I had seen since leaving Prairie river settlement. Unfortunately, there is at present no road by which this place could be reached, except the usual Indian pack trail. Large game abounds in this valley, and the trappers and Indian hunters of Sturgeon lake have built here many shanties, where they spend the winter.

The distance to Sturgeon lake would be about forty miles by the trails. The valley of Waskahigan river has been carefully explored by different railway survey parties. The location of their lines was recorded by my chainmen when we were surveying the north boundaries of the following sections:—

At 57	chs. W. of N.E. Cor.	Sec.	32	Tp.	64	Rge.	20	W. of 5th Mer.;	bearing	N.W. Mag.
6·73	" "		36	"	64	"	21	"		north "
50·07	" "		36	"	64	"	21	"		" "
72·33	" "		33	"	64	"	21	"		" "
43·05	" "		34	"	64	"	22	"		" "

These exploratory lines were surveyed across a high rolling country which is found not only in the vicinity of this river but continues for some distance to the west. The quality of the soil varies considerably along that part of the base lines which I surveyed. I will describe it now more fully taking each range in turn, beginning with the west half of range 19, township 64, west of the fifth meridian.

(NOTE.—Descriptions of the townships surveyed have been taken from this report and published as part of Appendix No. 46).

On July 2, having completed the survey of the seventeenth base line I started for Sturgeon lake over a pack trail located east of the one which I had followed in going to the same place in the fall of 1905. I was thus given an opportunity to learn more about the country west of the Waskahigan and Little Smoky rivers. This new pack trail which leaves Waskahigan river in section 5, township 65, range 22 passes over the high rolling lands overlooking Waskahigan river from the west and runs nearly parallel to it as far as the north boundary of township 65, range 22. Here it leaves the river which now turns more to the northeast in its course to Little Smoky river. The trail now descends to the valley of a large stream which rises in a hilly country many miles to the west. Beyond this creek are four miles of swamp. Thence the trail leads through higher lands extending north to a creek, which runs northeasterly across township 68, range 22. The trail now keeps along the right bank of the creek for three-quarters of a mile when it leaves it to connect with lake St. Ann pack trail two miles farther. Shortly after this we crossed the creek and continued our journey to the eighteenth base line where we camped on July 5, having travelled this far across a country mostly wooded with poplar, birch and some spruce.

Between the eighteenth base line and Sturgeon lake much of the land west of Little Smoky river is covered with a second growth of small poplar with willow scrub, the only spruce timber left being found in bluffs surrounded by narrow swamps or muskegs. I arrived at Sturgeon lake on July 7, and on the following Monday was travelling towards the sixth meridian, from which I had been instructed to survey westerly, forty-eight miles of the eighteenth base line. The road which I followed in going to the sixth base branches off from the main wagon road running along the south shore of Sturgeon lake just after crossing the bridge which now spans Goose river. If at some future time it becomes necessary to open a wagon road to Simonette river, this will be the direction to follow, as the pack trail is located through a fairly level and dry country thickly wooded with a second growth of poplar and birch. There are at present many openings of prairie land and land covered with small scrub along Moose river, this country having been overrun by a recent fire which burnt the impassable windfalls that covered it three years ago. The land thus cleared is available for immediate occupation and would permit of stock-raising and mixed farming on a small scale. This remark applies also to the country between Simonette river and its chief tributary from the west called Moose river.

SURVEY OF THE EIGHTEENTH BASE LINE.

The survey of the eighteenth base line was carried on under great difficulties and much risk owing to the bush fires which surrounded us and through which we had to cut a passage during the whole time that this survey lasted. The entire land surface along the eighteenth base had, until this year, been covered with a thick growth of large poplar, balm of Gilead, cottonwood, birch and spruce. Since the fire this has been changed to impassable windfall. It was expected that after crossing Smoky river we would be clear of the fire, but this did not prove to be the case for in that district also, forest fires were raging. These fires originated two years ago and, as only a few inches of snow fell in that district during the winter of 1905-6, the fires kept smouldering in the wooded sections of the country and when fanned by the wind started again all over the country in the spring of the next year. To the inconvenience resulting from the dense smoke which obscured the sky, must be added the continual danger of losing the camp equipage by fire. The initial point of the survey was the northeast corner of township 68, range 1, which I re-established according to instructions. At ten chains west of the sixth meridian this eighteenth base line crosses Moose river, which is here eighty links wide and was three feet deep at the time of survey. Its banks are ten to fifteen feet high. West of the river a flat, one-quarter of a mile wide, brings us to the foot of steep hills denuded of timber, which rise to a height of two hundred feet above the level of the river. Thence the surface of the country remains undulating and is dotted with many lakes, ponds and hay marshes most of which are connected at high water. Around some of these lakes quite a lot of hay could be cut. Such a lake three-quarters of a mile long by one-quarter of a mile wide occurs near the north boundary of section 29 in township 68, range 1. I noticed some surface stones through this township. This undulating country continues west to the middle of range 2, where it changes to five miles of high rolling country of sandy ridges with many small lakes surrounded by muskegs. West of these sand hills, the country is undulating with lakes and ponds here and there. Running across range 3 from east to west and extending to Smoky river I noticed a large depression probably occupied by a stream which joins the river three or four miles south of the line.

Smoky river crosses the line at the northeast corner of section 32, township 68, range 4. At this point the river is one hundred and thirty yards wide and flows between precipitous banks alternating with flats, at one time well wooded with large spruce. The valley is two miles wide. The bed of the river is three hundred and fifty feet lower than the bench lands on the west side and its channel, which is very tortuous, is frequently filled with large boulders causing dangerous rapids. Along its banks are accumulations of drift wood which extend far into the river and have cost the lives of many prospectors who were bold enough to trust themselves to its waters on a raft. The average velocity of the current cannot be less than eight miles an hour.

When I arrived at Smoky river with my survey I found the water so high and the current so swift that it could not be forded. We then built two large rafts which were to be propelled by means of poles. To make the crossing of the river doubly sure I also fitted oars to the rafts. This proved to be our salvation. Though of large size the raft on which I started was overloaded to such an extent that as soon as sent adrift it was fully covered with eight inches of water. In that condition it drifted diagonally across the river. Soon the water got so deep in the river that the poles became useless. It was then that the oars proved useful and assured our landing. The horses had to swim across but did so only after several fruitless attempts, in one of which it looked as if we would lose three of them. These horses at the start had left the rest and had struck out by themselves down stream. They were swept along by the force of the current in the main channel. At that point the main channel is very much narrowed by piles of boulders and the current runs through it like a mill-race. Here they were lost sight of in the seething waters, appearing for a few seconds above the top of the waves only to disappear again. At the lower end of that stretch of swift water the river takes a short turn to the left. Here are great piles of drift wood and the danger was that if any of them ever got caught under the drift piles they would be drowned. They were, however, carried past that obstacle, for shortly afterwards I saw one of them which had been carried into an eddy trying to climb over a large boulder whose surface had been worn smooth by the action of the current. However, he would only fall back into the river, after each fruitless attempt. He managed at last to reach the shore, but he was so exhausted that he remained there motionless just keeping part of his body above the water. It was in that position that men sent to bring him back found him. The others which we thought had been drowned, were found safe farther down, grazing along the banks of the river and they were brought back to camp. The place chosen for the crossing, was below an island which occupied most of the bed of the river. This island greatly diminished the current of the stream, forming here a large eddy close to the left bank of the river and making a good landing place. As there was no feed on the west side of the river the horses had to be driven upon the bench, but as fires were raging there, two men had to be left to guard them.

As with all streams which rise in the ice fields of the Rocky mountains, the highest stage of water on Smoky river occurs in the middle of the summer. At that time the larger percentage of clay which its waters hold in suspension gives them a peculiar grayish colour. It was noticed during our stay near the river in the first weeks of August that the water would fall during the night and rise again by the same amount the following day. From this I concluded that it took twenty-four hours for the freshet caused by the increased melting of the snow to travel from the headwaters to the latitude of the base line. Thus the average velocity of the current would be four miles an hour, though it is probable that in the high reaches of the river it is considerably more than that. When we crossed this stream a month later the water was not lowered to any appreciable extent. The left bank of Smoky river, where the line intersects, is precipitous and ends in a bench of very poor soil half a mile wide. The next stream crossed by the line was Big Mountain creek. At the time of the survey this creek was simply a succession of large and deep pools connected by small rivulets, but there were indications along the bank that in the flood the water reaches a high level, and the stream must be a regular torrent. Six miles south of the base line I noticed a range of hills 2,650 feet above sea level, where the creek probably has its source. One mile north of the line this stream receives from the west a tributary ten or twelve miles long. Its valley runs nearly parallel to the base line and contains a muskeg which effectually prevented the fire from spreading eastward.

Range 6 contains much high rolling land. The greater part is covered with scrub willow, and is thinly wooded with a second growth of poplar and birch. There is also some partly open country. The west half of this range is stony in places. All the brooks, large and small, crossed by the line, were dry, and the water for the use of the camp had to be drawn from wells dug in the muskegs which had not been overrun by fire. Later on, however, a flowing spring, which was discovered near the centre of section 31, supplied us with the only running water we had had since leaving Big Mountain creek. This spring feeds a creek which flows to the southeast, where it is reported to join Big Mountain creek. Another creek which crosses the line in section 32 runs northward and empties into the west branch of Big Mountain creek.

In range 7 the surface varies from rolling in the east half to undulating in the west half of the township. Here also the recent fires have cleared the land of much of the dead timber with which it was covered. From the northeast corner of section 32 the surface slopes down to the valley which cuts that section diagonally and where there are still bluffs of green timber. These bluffs, being surrounded by swamp, have so far escaped the ravages of the fire. In the southwest of this township some high ridges were noticed. Running streams are scarce, only two small creeks, five miles apart, crossing the north boundary of the township. There is a small hay meadow near the northeast corner of township 68, range 8. The surface of the country in range 8 is frequently broken by narrow sandy ridges running in general east and west, with many muskegs between. The soil is pretty uniform in quality, being a clay covered with about six inches of light soil. Stones were seen at different places in this township.

Three pack trails intersect the eighteenth base line between ranges 1 and 8, inclusive, west of the sixth meridian. The first one was noticed on the bench forming the left bank of Smoky river. It passes at thirty chains west of the northeast corner of section 32, township 68, range 4. This pack trail will be impassable now on account of the heavy windfalls which cover the country. The next one is well defined, and intersects the base line one-half mile east of Big Mountain creek. This trail leads to Wapiti river, ten miles to the north of the base line. After crossing this river it joins the trails to Saskatoon, Bear Lake and Grande Prairie Settlement. A third trail, also well travelled, crosses the line in the middle of section 31, township 68, range 6. It leads towards the north across four or five miles of pretty open country; thence through a forest which continues as far as Wapiti river. On the north side of this river it leads to the trading post at Saskatoon lake. From Lesser Slave lake I travelled seventy-five miles to Peace River Landing. Here I crossed with my outfit on the ferry and proceeded by wagon road to Brick's Settlement, thirteen miles to the southwest of the landing. I met Mr. Brick, the local member, and from him obtained much valuable information regarding the country which I was to survey.

On October 2, having received all my supplies, I left the settlement by the Dunvegan road, which I followed to its intersection with the old Hudson bay cart trail. From there I continued my journey in a northwesterly direction and camped at the south shore of Bear lake, within three miles of its west end. The next day I reached Last lake at the northeast corner of township 83, range 1, west of the sixth meridian. Between the settlement and Last lake are many poplar groves and willows, with patches of prairie, but there is very little timber of any use except for firewood. The soil is good throughout. North of Last lake we entered an undulating country, with some windfall and the remains of old brulé, which is at present overgrown with young poplar, birch and willow scrub.

On October 8, we struck the twenty-second base line, surveyed many years ago, and consequently hardly visible, and camped near a creek a quarter of a mile east of the northeast corner of township 84, the initial point of my survey.

SURVEY OF PART OF THE TWENTY-SECOND BASE LINE FROM RANGE 21 TO THE SIXTH MERIDIAN.

The twenty-second base line runs at a short distance south of the summit of Whitemud hills which divide the valleys of Peace and Whitemud rivers. These hills rise above the surrounding country from three hundred to five hundred feet and cross the sixth meridian in township 85. From the sixth meridian they extend east as far as range 25 west of the fifth meridian. In that distance, thirteen and one-half miles of rolling country, the land is strewn with much dead timber. It is also stony in places in the east half of range 25. No prairie exists at present along this base line, but were any fire to get started, a pretty clean sweep would be made of all that dead timber, and this would render that part of the country valuable for grazing purposes. In many other sections where this has occurred, the land has grown in great profusion nutritious grasses such as peavine, etc. Numerous brooks take their rise in the ponds and marshes at the summit and flow down from these hills in all directions. Those which flow north, run into Whitemud river, while streams flowing south, empty into Bear lake which is about eight miles long by three miles wide. The land at both extremities of this lake and for some distance along its south shore is said to be boggy, and this saved from the fires a very small area northeast of Bear lake. Here to-day can be found a strip of green spruce three miles wide. Since 1896 fires have overrun the country along Peace river and therefore this part is full of windfall. The same remark applies to the range and a half adjoining the sixth meridian. The rest of the country, especially the summit of Whitemud hills, is made impassable by the large number of dead trees on the ground. The soil in the fractional range 26 and in the whole of range 25 is black loam from two to five inches in depth with a clay subsoil. All the streams are small and flow south towards a creek which enters Bear lake near the west end. This creek crosses the line near the northeast corner of section 31, range 25, and flows through a high rolling country while along one bank runs a well defined pack trail which leads to the west end of Bear lake. Small brooks flowing south cross the boundary nearly every mile. From range 25 the ground slopes eastward throughout range 24 and there the rolling country ends, the country from that point to the outlet of Bear lake in section 32, range 23 being level. There are here some hay meadows and tamarack swamps that drain into the outlet of Bear lake. This outlet, a sluggish stream forty links wide with a soft muddy bottom, flows north into Whitemud river, crossing the line near the northeast corner of section 32. The divide between its valley and that of Peace river is crossed at the northeast corner of section 33. The approaches to this stream are boggy and it was found necessary to make a corduroy road and to throw a bridge over the creek before it could be crossed by the pack animals. East of the stream the surface of the country changes from undulating to rolling. Three miles beyond the divide is another stream which rises from three lakes lying four miles north of the base line. Hay lands, in irregular patches, are found around these lakes and along this creek. A rancher, Mr. St. Germain, has cut twenty miles of roads from his farm on Peace river to these lakes, which is the nearest place where sufficient hay can be procured to feed his cattle. It is now his intention to cut this road northward to Whitemud river, which he claims is not very distant and where extensive prairies are reported to exist. Through range 22, there are many hay meadows, the largest being in the east half of section 33. From the northeast corner of section 35 the ground begins to slope down gradually to the west edge of Peace river valley. From that point precipitous cutbanks lead to the river banks, a drop of seven hundred feet in half a mile. On the fourth, the survey having been carried as far as the river, we returned to the landing, effecting the crossing of the river, just before this became impossible on account of floating ice. From the Hudson's Bay company's trading post at Peace River Landing, we cut a trail along the river to the twenty-second base line, and camped near an island close to its right bank. The distance across Peace river on the line is eight hundred and fifty yards, from shore to shore and six hundred and thirty yards between its left bank and the near shore of an island, separated by a narrow channel from the right bank. The summit of the bench which faces the river from the east, occurs at one and three-quarter miles from the river and is seven hundred feet above the river. This bench is thirty chains wide; then a gulch six hundred and seventy-five feet deep and three-quarters of a mile wide occurs. Then a second bench also thirty chains wide is followed by a very wide and deep ravine. On the west slope of this ravine was erected the monument which marks the northeast corner of township 84, range 21, west of the fifth meridian. This ended my survey of the twenty-second base line.

Description of the country along part of the twenty-first base line through ranges 21, 22, 23 and 24, all west of the fifth meridian.

(NOTE.—Descriptions of townships surveyed have been taken from this report and published as part of Appendix No. 46.)

Description of the country along the twenty-second base line between range 21, west of the fifth meridian, and the sixth meridian.

(NOTE.—Descriptions of townships surveyed have been taken from this report and published as part of Appendix No. 46.)

When I returned to Peace River Landing after completing the survey of the twenty-second base line, I was informed that there was a pack trail from the Hudson's Bay company's post. It runs north for twenty-five miles, which would bring it to Cadotte river. This trail might prove to be the right one to use in going to the twenty-second base line if, at any future time, it was decided to have it surveyed farther east. By following it, all the deep gulches in the vicinity of Peace river could thus be avoided.

West of Peace river the following well defined pack trails, which intersect the twenty-second base line were noted:—

A pack trail, running north and south, intersects the north boundary of section 32 in township 84, range 25. It is located on the left bank of a good sized stream flowing into Bear lake. Four miles south of the base line it leaves the valley of the creek, and turning a little to the east, passes close to two small lakes, before it comes to the west extremity of Bear lake. Another well travelled trail is the one which crosses the north boundary of section 36, range 24. From its intersection with the line, it leads northerly to Whitemud river, and southerly to the Roman Catholic mission on Peace river. It passes close to the north end of Bear lake. There is also our wagon road which runs north from Last lake to join the wagon road opened by Mr. Selby along the base line, west of the sixth meridian. It was found necessary to continue this road easterly to range 23. The settlers at Peace River Landing and at Brick's settlement are at a great disadvantage as far as their supply of hay is concerned. Those living along the road leading from the Landing to Brick's Settlement have to go over twenty miles, but even at that distance they cannot procure all they require. They are going to continue the hay roads several miles north of the base in order to reach some meadows surrounding a group of lakes, around which they expect to procure more hay. At Brick's Settlement, they have to go as far as Last lake, a distance of twenty-five miles. Around Bear lake some hay could also be put up, but the supply is not assured as it depends much on the depth of water in the lake. Those living on the right bank of Peace river have to travel southeast to Little Prairie, twenty-two miles distant. This district supplies most of what is required at the Landing. The northern limit of the forested country which extends northward from the Landing, runs parallel to the north boundary of range 21 and within a short distance of it. East of range 21, the most easterly range surveyed by me, the country is level. There most of the country seems to have been over-run by fire five years ago and what appeared to be partly open country was noticed north of the future location of the twenty-second base line. I am informed that a well travelled pack trail, which begins at the Landing, runs through that section for twenty-five miles, which would bring it to Cadotte river. Whenever it is decided to continue the survey of that base line, this trail will be the proper one to follow as it goes far enough east of Peace river to avoid all the wide deep gulches which lead down to it.

On November 15, we returned to the Hudson's Bay company's trading post at the Landing, whence I proceeded to Little Prairie, a distance of twenty-four miles. in a southeasterly direction. We stopped at the place of Archy Campeau, a half-breed squatter, who agreed to supply baled hay and grain, and to deliver it on the line wherever it would be most needed. There was, at that time, enough snow to make good sleighing, so I rented two sets of sleds. I also kept five horses, out of the sixteen I had, and provided a tent for them. The others were driven back to Prairie Settlement for the winter. From Archy Campeau's it was found necessary to open a sled road westward to Smoky river. On the 20th we moved seven miles in a southwesterly direction and camped at a small prairie, close to a good-sized creek. For the first three miles from Campeau's the trail runs across prairie lands, with scattered clumps of willow and a few poplar bluffs. This sort of country extends to the valley of North Heart river, a stream one chain wide and three or four feet deep. The water runs swiftly over a gravelled bottom. On each side of the river, at some distance from the bank, there is a bench of land fifty feet high. Across the river the land is thinly timbered with poplar and birch and many small prairie openings surrounded by willow scrub. The men were daily kept at work on the road. On December 15 we reached the valley of Smoky river, having come through a nearly level country fairly well wooded. The forest is partly free of underbrush, and as there is no windfall, we made good progress with the road, considering the short days. The land is a good clay with a few inches of alluvial soil on top. Range 21 and the east half of range 22 are well watered by numerous running streams, while in the west half of range 22 are extensive hay meadows occupying shallow depressions parallel with the general course of the river, distant three miles west. On December 15 we reached the valley of Smoky river, but its banks are so high and so precipitous, that I saw at once the impossibility of travelling any farther west with the sleds. Explorations were begun along the banks of the river, and a gulch leading to the river was discovered. This gulch follows the north boundary of section 3, township 80, range 23 and, though its bottom was found piled high with dead trees, and though its sides were very steep in places, I managed to clear a pack trail down this ravine to Smoky river. West of the river another gulch was found, one mile south of that one followed on the opposite side. Up this first gulch the ascent is more gradual, and it was a comparatively easy matter to get to the top of the bench, seven hundred feet above the river. From the valley of Smoky river to the east boundary of township 80, range 25, the distance is eight miles through wooded country. On December 25 the pack trail had been opened to within three-quarters of a mile of the initial point of my survey.

The survey of the north boundary of township 80, range 24, was made according to your instructions, and by January 9, the work had been carried east as far as Smoky river, which flows from south to north across the middle of this township. The whole country west of Smoky river is undulating, covered with much underbrush and wooded with timber averaging twelve inches in diameter. The soil is five or six inches of black loam with a subsoil of clay. Owing to the proximity of the valleys of Peace and Smoky rivers no large creeks were crossed by the line; still sufficient water could be found in the numerous willow swamps which dot this part of the country. A large muskeg extends north of section 33, and small streams flowing north cross the north boundary of section 32. On the line Smoky river is three hundred and thirty yards wide. It is a swift flowing stream, whose channel is frequently obstructed by large quantities of boulders. Its valley from side to side is one mile and one-quarter wide, and is inclosed between high mud banks with only a narrow margin of flat land next the banks of the river.

Range 21 being in the basin of North Heart river, is well watered by several tributaries of that stream. At a quarter of a mile south of the north boundary of section 31, there is a large hay meadow. All through this range there are many willow swamps from which rise nearly all the creeks flowing southeasterly into North Heart river. The west branch of the pack trail from Little Prairie, crosses the line in section 34. This country along Smoky river is now made accessible, from Little Prairie, by means of the road which I had to open westward, between the Peace river wagon road and Smoky river. All the prairie land found at Little Prairie would be included in the north half of township 80, range 18, the west half of township 81, range 18, and in the east half of township 81, range 19, all west of the fifth meridian. There are at present living at Little Prairie, a few halfbreeds, trappers and freighters who have located along the Peace river road. They keep cattle and horses and put up hay in very large quantities, with which they supply the freighters and the settlers at the Landing. They have not yet attempted any kind of cultivation though the land is fertile and well watered by North Heart river and its many tributaries.

On January 31, I left Little Prairie for Lesser Slave lake, where I arrived on February 2. Here I stored part of my outfit with Mr. M. Revillon, and the five horses which we had kept on the winter work, and some outfit and supplies were turned over to Mr. O. D. Hill, of Prairie River Settlement, to be cared for till such time as they would be required again by the government surveyors. I then made arrangements with Mr. Hawkins to bring my party down as far as Athabaska Landing. From that place I went to Edmonton with some returning freighters. Here I received your instructions as to the shipment over the winter roads towards the mountains, of supplies which would be required by surveyors to be employed during the next summer. I found it necessary to give my personal attention to every detail, and left only after I had seen each surveyor's supplies and survey posts separately loaded and made ready for their destination.

My surveys of last season were distributed over a large area, which necessitated long trips between each work and considerable road cutting in places. Besides, the forest fires, which were overrunning the country along the eighteenth base line west of the sixth meridian, were so fierce, at times, on this line, that it was very doubtful many times, where we would pass through, and I must say that it was only by taking every chance that this was successfully done.

Large game is found everywhere in these woods. Large colonies of beavers were seen on almost every stream, where coyotes and other fur-bearing animals are numerous. In the streams, pike, pickerel and trout were caught. As to minerals, coal is the principal one found so far, and there seems to be no scarcity of it. According to people who have lived there for some years, the climate of that part of the country is better than that of the country to the south.

I have the honour to be, sir,
Your obedient servant,

ARTHUR SAINT CYR, *D.L.S.*

APPENDIX No. 39.

REPORT OF J. B. SAINT CYR, D.L.S.

SURVEYS AND RESURVEYS IN MANITOBA.

STE. ANNE DE LA PÉRADE, QUE., December 13, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to report as follows on the survey and resurvey made in Manitoba in October and November, 1906.

On my arrival in Edmonton from the Peace River district, October 12, I received your telegram telling me to go to Pipestone, Manitoba, where instructions were awaiting me. I left Strathcona on October 23, having been delayed in Edmonton waiting for my baggage from Athabaska Landing, and arrived at Pipestone the 25th of the same month.

Having made the necessary arrangements, the following day I began the survey of that portion of township 6, range 26, west of the principal meridian, which had not been previously made, the country being flooded at the time of the original survey. I also made the resurvey of some of the old lines, as a few corners could not be found by the owners of the land. This survey was completed on November 10.

(NOTE.—Descriptions of the townships surveyed have been taken from this report and published as part of Appendix No. 46.)

On November 6, I commenced the survey of all the section lines in township 6, range 25, around Marshy lake and adjoining the south part of a great marsh, generally called Maple lake by the people of that place. I also made the resurvey of the lines of sections 5, 6 and 7, in the same township. The whole was completed on November 23.

On November 12, I went to township 6, range 27, to settle a difficulty between settlers about corners of sections 19, 20, 30 and 29. Having brought these people to a certain agreement, I surveyed the north boundary of sections 19 and 20 as indicated on the original plan, fixing and marking the different corners with cedar posts and making the proper mounding.

Reston is the nearest railroad station from this township; it is situated about three miles north of section 19. There are grain elevators also in this important place. I noticed here, as well as in the adjoining townships, that very large fields had been ploughed by the settlers. The farmers seem to be well off, and have great faith in the future of this wheat-growing country.

November 23 I left Pipestone, Manitoba, on my way home.

I have the honour to be, sir,
Your obedient servant,
J. B. SAINT CYR, *D.L.S.*

APPENDIX No. 40.

REPORT OF J. B. SAINT CYR, D.L.S.

SURVEY OF SETTLEMENTS IN PEACE RIVER DISTRICT.

STE. ANNE DE LA PÉRADE, QUE., December 5, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following general report of my field operations during the past season in the Peace River district, together with some information regarding the country in the neighbourhood of Fort Vermilion.

In accordance with your instructions, dated May 2, 1906, I left Ste. Anne de la Pérade on the 12th of the same month for the Northwest.

On May 18, I left Edmonton, and on June 14, I arrived at Fort Vermilion, Peace river valley. I spent several days forming a party in order to do the survey of Fort Vermilion Settlement (south of Peace river). This was a rather difficult task, especially in that country where people have a great deal of work to do on their farms. Grain culture has paid well at Fort Vermilion in recent years, the Hudson's Bay company paying as much as one dollar and fifty cents a bushel for wheat. Otherwise the farmers who may have some spare days are engaged with the company to work at the mills, on their farm, at some buildings in construction and on the steamer.

On June 19, I began the survey of Fort Vermilion Settlement, which I closed on July 28, all my men having gone for the hay harvest. This settlement extends over six ranges containing in all fifty-five lots of various dimensions. Every range line runs east and west and the division lines of the lots north and south.

A tract of land of about three miles and a half from east to west by three miles and a quarter from south to north forms that portion of the settlement surveyed. The Hudson's Bay company has its reserve adjoining Peace river and nearly in the middle of the settlement. The subdivision has been made in such a way as to give to every settler his improvements.

The general aspect of the country is prairie and bluffs and the soil is a black sandy loam overlying a clay and sandy subsoil. The bluffs are timbered with spruce and poplar three to fifteen inches in diameter, with clumps of large tangled willow. The bank of the river stands about eighteen feet above low water mark. The land is level in the central portion of the settlement to a third of a mile inland where the ground rises about fifteen or eighteen feet. From the summit of that elevation an immense plateau extends towards the east, the south and the southwest.

No minerals of economic value were found during the progress of the survey, and there is no water-power. Hay is rather scarce here; settlers have to go as far as ten or fifteen miles and sometimes more to procure the quantity required to feed their cattle during the winter. Wood for fuel is very plentiful.

I will give further on, details of the climate, the general resources and features of that portion of Alberta. The Hudson's Bay company own a very extensive establishment at Fort Vermilion, including a sawmill and a modern flour mill. The two missions have also a number of buildings and cultivate large fields. The most of the settlers around Fort Vermilion last summer had from forty to a hundred acres under crop. Besides the missions and the Hudson's Bay company there are twenty farmers south of the river on an area of about ten miles by three miles. Mr. Sheridan Lawrence is one of the biggest farmers there and has an extensive farm at Prairie Point, fifteen miles above Fort Vermilion on the north side of Peace river. Mr. Lawrence's crop last fall was nearly five thousand bushels of wheat and two thousand bushels of oats and barley. Very good buildings have been erected there by him. Every one of these farmers has a large number of cattle and horses and have all the implements necessary on a farm.

Among the petitioners to the government some are no longer residents of Fort Vermilion, viz.: Erastus John Lawrence, Clara Lawrence, Henry H. Lawrence, Prudent d'Amour, Minnie E. Lawrence, Paul Meechatsio, Henry P. Panter (residing at Peace River Landing), Clement Paul (at Keg river), Xavier Sawan (at Wolverine point) and John Flett. They have sold out their buildings and improvements on the farms formerly occupied by them.

Peace river is very beautiful and wide, with a current of about five miles an hour at high water and two to three miles an hour during the low water period. The channel varies a good deal in depth in different places on account of the sand and gravel bars which nearly cross the river. In front of the Hudson's Bay company's reserve, I found that the deepest parts of the channel measured thirty-four feet at low water, in the month of October. When the snow is melting in the mountains in the months of June and July, the river rises sometimes ten to fifteen feet above low water mark. A great number of well timbered islands are seen all along the river.

On June 20, I began the subdivision of North Vermilion Settlement (north of Peace river), which I completed on September 5. The country there is more timbered than in the other settlement. All the fields now under cultivation have been cleared. The soil is of a better quality, being a deep black loam resting on a clay or sandy clay subsoil. This settlement consists of only one range with fifteen lots in it. I have been obliged to give to the division lines, to correspond with the improvements of the settlers, a bearing of 334° 00′ instead of north and south. The timber consists of poplar and spruce varying from six to fifteen inches in diameter with patches of thick large willow. The country is undulating on that side of Peace river. Hay is plentiful along Gull lake, Gull creek and Shoal lake north of this settlement. Gull creek is the only stream in this settlement. It was dry last summer and can be used as a water-power only in the spring or in rainy summers. The Roman Catholic mission has built a dam and erected a mill on that creek in lot No. 4. There are two fur trading posts here, one store owned by the Hudson's Bay company and the other by Revillon Bros. Both companies are doing well, for the fur-bearing animals abound in all the surrounding region. There are only seven farmers in this settlement. No mineral of any description has been found. Before the commencement of this second survey I made a traverse of Peace river and of the islands, connecting the two settlements to get the distance across the river and to establish the respective positions of these.

On September 12 I started the subdivision at Boyer Settlement and on the 24th of the same month I was forced to close the survey because the few men I had, were leaving the work to do their ploughing. As it was useless for me to think of forming another party to complete this survey and that of Fort Vermilion, I left the place on September 25 on my way to Athabaska Landing. I arrived in Edmonton on October 12, where I received your telegram telling me to go to Pipestone to make certain surveys in Manitoba.

In Boyer Settlement the soil is of first quality almost entirely. It is composed of a deep black loam and black sandy loam overlying a clay and sandy clay subsoil. This country is undulating and the surface is prairie and bluffs principally timbered with poplar and spruce mixed with large willow. This timber measures from six to fourteen inches in diameter. This settlement is bounded on the north by Boyer river flowing into Peace river The first mentioned stream has a depth of two to fifteen feet and a width of about a chain and a half to two chains, and a current of a mile and a half an hour. A few miles west of the settlement the river is divided into two branches, one coming from the northwest and the other taking its water twenty or twenty-five miles west of Wolverine point, in the neighbourhood of Keg river. The hills adjoining the river are from sixty to seventy feet high and their slopes are thickly timbered with poplar, cottonwood, spruce and large willow.

Boyer settlement contains thirty-one lots and is connected with the other near Peace river by the prolongation of the division line between lots No. 5 and No. 6.

The people travel from one village to the other by two wagon roads, one of which starts from the southwest corner of lot 5 and the other one passes between lots 22 and 23, meeting one another near the fur trading posts situated on the north side of Peace river. Hay is abundant around Gull lake and Shoal lake and also along Gull creek. Shoal lake was nearly dry last summer. No mineral of any description has been found here during the survey.

Particulars about the country through which I travelled last summer and means of communication.

In the country surroundng Lesser Slave lake and along the river of the same name the soil is very good. The surface is mostly bluffs and prairie in the neighbourhood of Swan river, Driftpile river, and also in the upper part of Lesser Slave river. There is more bush than prairie in those places and along the trail leading to Peace River Landing and also along Athabaska river, but the soil is of first quality.

Peace river flows between hills seven hundred to eight hundred feet high, for a long distance above and below Peace River Landing Nevertheless there are small flats of alluvial deposits here and there close to the river banks. The country is nearly level on top of the above mentioned hills bordering Peace river. The low valley of the river begins to widen near Wolverine point, about two hundred miles below Peace River Landing, and at Fort Vermilion it extends from forty to fifty miles into the interior on both sides of the river.

From Keg river, west of Wolverine point and following the bank south of Boyer river the prairie runs as far as Boyer Settlement, and northwest of this last place to a distance of about fifty miles. With the exception of a belt of bush ten miles wide, the country is mostly prairie and the soil very good. There are a few muskegs here and there, but the land fit for cultivation is very extensive. A prairie thirty miles long lies also north of Buffalo Head mountain with some very good hay ground. There is nearly twenty miles of forest between this open country and Fort Vermilion. Scattered patches of prairie three to five miles in diameter are met with north of Peace river from Vermilion falls to Caribou creek. Large openings in prairie can also be seen along the road from Mustus lake to Fort Vermilion in an approximate distance of twenty-five miles.

The lower Peace river valley is reached with more facility than it used to be a few years ago owing to the newly opened trail from Athabaska Landing to the mouth of Lesser Slave river, and from this last point there is another wagon road passing on the north side of the above-mentioned river, which connects with the trail south of Lesser Slave lake. From the upper end of this lake the Peace River Landing wagon road strikes one of the navigable points on Peace river.

The Hudson's Bay company are the owners of a large steamer *The Peace River,* making three full trips every summer from Fort Vermilion and the Falls to Peace River Landing, Dunvegan and St. John and sometimes to Hudson Hope, forming about eight hundred miles of good navigation. Some of the residents of Vermilion often build rafts at Peace River Landing to take down the river horses, agricultural implements provisions and furniture. In the spring time they generally reach Fort Vermilion in four days as the current is very strong. The first trip of the steamer up the river is made in the latter part of May and her last trip down stream is in September, though the season of navigation could be counted from the middle of May to the last days of October. I obtained from Mr. F. A Wilson, manager of the Hudson's Bay company's post of Fort Vermilion, a record showing at what time the river freezes in the fall and at what date it is clear of ice in the spring at Fort Vermilion.

GENERAL RESOURCES OF THE COUNTRY.

As stated above large tracts of the best land, some in bush and some in prairie, can be located all through the country, which are very well adapted for farming and ranching. On account of the small elevation above the sea, of the lower Peace river valley ,the climate is comparatively good, very warm in the summer and not very cold in winter.

The farmers and immigrants will find there, a very fertile soil, growing admirably wheat, oats and barley, also all kinds of vegetables, and they will be in a position to compete with farmers of the other northern provinces in the Dominion. The wheat grown there is of first quality and ripens rapidly during the long summer days. I have seen extra good, large vegetables in every garden and field of the settlements around Vermilion. I measured some heads of cabbage four feet in circumference. The turnips, potatoes, carrots, &c., grow also to a very large size.

The timber found in the Peace river valley is poplar, cottonwood, spruce and willow, with a few white birch here and there. Spruce suitable for commercial timber is seen more or less in the vicinity of the river. There is a continuous succession of islands in this large river, thickly timbered with spruce of good quality.

The Hudson's Bay company has erected a modern flour mill and a sawmill. Both are operated by steam power and situated on the company's reserve at Fort Vermilion. The flour mill has a capacity of forty to fifty barrels a day, while the sawmill can turn into lumber in a day, one hundred logs. The Roman Catholic mission have also on Gull creek, north of Peace river, a flour mill of a capacity of ten or fifteen barrels a day, and the sawmill will probably saw twenty or thirty logs a day.

Great deposits of limestone are found at Vermilion falls and near Red river forty miles farther down the river. A large quantity of very good lime is manufactured every year by the people of the country. Ordinary salt exists in large quantity near Salt river, a tributary of Peace river and situated about one hundred and thirty miles below Vermilion falls.

There is a seam of soft coal sixty or seventy feet above the level of the river at the place called 'The Cliff,' fifteen miles north of Peace River Landing. The seam appears to be from three to five feet thick, and the coal is reported to be of good quality.

The principal mountains in view of Vermilion are the Buffalo Head mountain south of the river, and Caribou mountain lying north and northeast at a great distance from the river. I have been told by some hunters that very large lakes well stocked with trout and whitefish are found on these mountains. Bears, moose, lynx, marten, mink and foxes are very plentiful. Thousands, I should say, of wild geese and ducks of different species are seen all through that country.

CLIMATE.

All last summer the temperature was very fine, although somewhat warm. We did not have many rainy days. The vegetation is very luxuriant and rapid in the Peace river valley. When I left Edmonton on the 23rd of May last, the grass was only beginning to shoot out of the ground, and on my arrival at Peace River Landing the 8th June, on the river flat the new grass was over a foot long and the rose bushes were all in bloom. Similarly this fall when I left Peace River Landing the 2nd October the leaves of the trees were but little injured by the frost, and at Athabaska Landing the 10th of the same month the trees were completely stripped. Any old timers in the Peace river valley say that the winter is not so severe there as it is in many other localities farther south. The stiff cold may last two or three days at a time, after which the weather becomes milder for a week or two. The fall of snow during the winter may be compared to that of the province of Quebec in the St. Lawrence valley, being from two to four feet.

I am indebted to Mr. Alfred S. White, missionary of Fort Vermilion, for a record of the extremes of temperature from September, 1905, to August, 1906, which I have annexed to this report. I have had also some information from Father C. H. Joussard and Father Habey, also missionaries at Fort Vermilion, regarding the country. As these gentlemen have travelled this district in all directions in the summer as well as in the winter, for years, they are very well informed about the different resources of the country. I have myself explored in a radius of fifteen to twenty miles around Vermilion and found the country exactly as represented to me.

I do not doubt that before long this lower Peace river valley will prove furthermore to be exceedingly good in all respects.

I have the honour to be, sir,
Your obedient servant,

J. B. SAINT CYR, *D.L.S.*

RECORD of the breaking up of the ice in the spring, and also of the first crossing on the ice of Peace river at Fort Vermilion, from the year 1890 to 1906.

Year.	Ice Move.	First Crossing of the River in Boat.	Ice Drift.	First Crossing on the Ice.	Remarks.
1890 ..	May 4....	May 8........	November 16...	November 30...	Current on Peace River is nearly five miles an hour at high water and one and one-half to two miles an hour at low water.
1891....	April 23....	" 1...	October 29...	" 12...	
1892...	May 11 ...	" 15........	November 4...	" 8...	
1893...	" 3...	" 10	October 31...	" 4...	
1894...	April 29 ...	" 6........	November 1...	" 10. .	
1895....	" 25....	April 29... ...	" 7 ..	" 15...	
1896...	May 2....	May 5..	" 7...	" 10...	
1897....	April 20....	April 26.... ...	" 10...	" 13...	
1898....	" 25....	" 27........	October 27...	" 1...	
1899....	May 5....	May 10.	" 20...	" 12...	
1900....	April 14....	April 20........	November 4...	" 15...	
1901....	" 26....	May 3	" 2...	" 6..	
1902....	May 1....	" 6...... ..	" 4...	....	
1903....	" 3....	" 13........	" 11 ..	November 19..	
1904....	April 17.. .	April 24.......	" 16...	" 30. .	
1905....	" 27...	" 30.......	October 23...	" 1 .	
1906 ..	" 20 ...	" 22........	....	....	

RECORD of Extremes of Temperature, Fort Vermilion, Peace River, from September, 1905, to August, 1906.

Dates.	1905.								1906.															
	September.		October.		November.		December.		January.		February.		March.		April.		May.		June.		July.		August.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min
1	70·0	38·4	44·5	22·7	37·0	8·4	3·0	-14·0	12·0	-4·0	8·0	-0·4	14·5	2·0	44·8	14·5	59·0	33·0	69·0	42·7	87·8	52·3	67·0	34·5
2	77·0	47·5	48·5	27·0	26·5	10·6	16·0	3·1	5·8	-5·6	12·0	-21·2	29·0	5·8	44·0	21·9	48·0	33·0	76·8	37·5	93·7	54·0	76·0	39·5
3	74·3	48·0	41·2	32·0	30·5	12·2	19·0	2·0	32·0	-3·5	3·5	-16·2	32·5	14·8	53·0	22·0	44·9	29·7	73·4	46·4	93·7	61·2	76·0	50·0
4	76·2	42·8	41·8	29·0	27·5	12·8	21·0	5·4	31·5	-12·0	4·7	-29·2	32·8	-6·0	34·0	22·0	45·5	25·0	74·6	52·4	88·2	59·7	77·0	49·5
5	69·3	46·5	44·4	28·0	29·0	15·0	24·0	-7·0	-6·0	-27·0	5·0	-18·6	40·2	1·5	47·7	22·1	54·0	29·0	73·0	42·5	83·5	49·0	82·5	49·0
6	57·2	47·5	44·3	32·0	33·6	17·0	16·0	-7·0	-12·5	-23·0	12·9	4·7	47·0	18·0	52·3	19·6	52·5	25·0	78·0	42·5	87·5	45·0	76·5	50·5
7	59·4	34·7	42·8	31·6	42·0	21·8	3·0	-20·0	-9·0	-19·5	16·0	-11·0	42·0	21·0	58·0	21·0	47·8	23·5	70·0	54·0	88·5	58·5	70·8	50·5
8	59·9	30·5	44·2	33·0	29·0	9·6	3·8	-13·8	41·0	7·0	16·3	-1·2	33·0	5·0	54·8	37·8	. .	27·0	57·4	50·2	92·0	65·0	70·5	46·5
9	60·5	34·0	45·0	22·0	39·6	9·0	......	......	34·0	-28·9	16·2	2·0	15·0	-21·0	49·8	22·1	68·5	.....	60·5	52·3	85·7	48·0	78·5	44·8
10	46·2	35·0	43·9	30·0	28·8	14·0	21·1	5·0	-9·0	-28·0	17·0	-12·0	7·2	-30·0	53·6	27·3	65·0	31·8	....	.	84·5	58·8	66·0	50·0
11	43·1	26·5	54·8	35·0	......	22·0	3·2	-17·3	-2·0	22·0	11·5	-4·2	10·0	-30·2	45·7	22·7	67·4	40·7	69·0	38.0	71·5	51·5	80·0	51·8
12	61·5	......	.....	28·8	47·5	21·9	0·7	-12·7	-13·5	-2·5	-12·0	-30·0	9·8	-28·2	60·5	28·5	69·0	37·0	60·8	46·0	74·0	51·0	78·0	57·5
13	60·8	40·9	42·0	29·9	36·0	28·4	12·0	2·0	-13·0	-26·0	13·0	-21·2	17·0	-26·0	60·3	30·5	69·0	44·0	69·4	38·0	82·5	48·0	78·8	51·0
14	58·0	41·0	47·0	26·8	43·0	23·0	29·0	11·6	-16·0	-43·0	9·0	-15·2	24·0	-9·0	62·2	38·0	53·0	41·1	73·0	49·8	87·0	54·0	72·5	42·5
15	61·6	31·2	37·0	24·0	44·0	23·0	19·0	4·5	-22·0	-43·0	-6·0	-16·0	......	.....	65·3	35·7	60·2	40·0	66·0	44·0	87·2	59·2	77·5	45·0
16	63·0	40·1	29·2	5·1	40·6	13·8	10·0	-9·0	-17·0	-40·0	4·5	-10·5	30·0	-5·0	67·0	30·8	60·7	37·3	......	44·0	81·0	40·8	60·5	33·5
17	59·8	30·0	20·9	-2·9	34·5	21·0	......	......	-15·0	-34·9	12·5	-6·5	11·0	-15·0	56·0	26·1	67·6	29·4	74·6	39·5	70·8	48·0	62·5	33·8
18	59·9	33·0	24·4	5·4	36·8	15·8	4·0	-19·0	-12·7	-24·5	11·9	7·0	21·0	0·0	59·3	37·7	70·3	35·0	......	.	74·8	51·0	65·5	39·5
19	69·5	34·0	29·0	14·1	34·0	9·3	3·8	-8·0	-16·0	-33·5	12·0	6·0	29·5	-13·0	51·8	29·0	74·5	45·5	70·2	42·2	77·5	45·6	63·5	37·0
20	58·1	30·0	36·4	23·2	29·4	12·9	5·0	8·0	-27·0	-47·0	13·6	6·0	25·5	-18·0	56·1	27·6	73·8	36·5	69·0	44·4	67·5	44·0	67·5	35·8
21	61·5	25·0	34·4	19·0	38·0	19·8	-3·0	-20·2	-31·0	-46·2	17·2	0·6	18·5	-4·0	60·5	31·0	73·7	41·6	71·5	41·5	80·0	46·0	72·0	34·5
22	48·3	31·3	21·1	12·8	31·9	4·0	7·5	8·0	-27·0	-42·0	5·2	-39·2	17·5	0·0	63·8	37·0	67·8	36·8	81·0	50·0	84·5	50·5	76·5	44·5
23	51·0	33·8	23·7	13·0	29·6	15·5	......	......	20·1	28·0	0·8	38·2	33·0	4·5	66·0	30·0	59·5	36·8	84·3	46·5	85·0	50·0	70·5	50·0
24	54·5	35·0	21·3	19·7	32·2	13·4	8·0	-8·0	16·0	-22·9	-0·3	-27·0	31·0	7·0	58·0	29·2	65·4	44·0	89·0	52·0	87·3	48·5	59·2	35·2
25	49·6	32·0	21·0	6·5	21·2	-15·0	5·1	-7·1	-0·5	-16·0	4·5	-22·0	37·8	4·0	52·5	30·0	71·2	46·2	87·0	57·5	82·5	55·5	68·5	44·0
26	49·2	34·6	17·7	3·9	10·2	-21·5	0·2	-10·1	-8·0	-5·0	16·2	-15·0	50·5	17·0	65·0	36·1	66·5	39·7	77·0	54·5	79·3	59·2	60·0	39·8
27	49·0	31·0	12·0	1·0	-2·0	-18·5	-1·0	-11·0	16·0	......	12·0	-5·5	47·5	20·0	63·5	35·7	68·8	33·8	68·0	54·0	79·0	50·0	59·0	31·0
28	42·7	33·8	19·0	4·0	-2·2	-15·2	-3·5	-9·3	10·5	-5·0	9·2	-8·5	49·0	21·0	66·4	32·0	71·9	37·0	71·5	58·0	80·0	57·5	57·8	28·5
29	44·1	31·0	27·0	8·5	0·2	-22·0	-14·1	-31·6	0·0	-12·2	.....	.....	55·7	....	65·0	33·3	70·8	47·5	77·0	58·5	74·5	50·0	61·2	33·2
30	41·1	32·2	27·8	8·8	-0·2	-21·5	-3·8	-16·3	11·0	-1·3	...	.....	52·0	35·0	68·3	39·0	80·2	44·5	76·0	52·0	77·5	53·8	67·0	40·0
31	.....	.....	19·2	5·8	.....	.....	6·1	24·1	5·5	-22·0	.....	.....	57·5	33·0	......	......	81·0	49·0	.....	.....	60·0	50·5	68·5	37·0

APPENDIX No. 41.

REPORT OF H. W. SELBY, D.L.S.

SURVEYS IN NORTHERN ALBERTA.

TORONTO, March 9, 1907.

E. DEVILLE, Esq. LL.D.,
Surveyor General,
Ottawa, Ont.

SIR,—I have the honour to submit the following report on the survey of township outlines and the subdivision of those lands which in my judgment should be made available, by survey, for immediate settlement at or near the westerly end of Lesser Slave lake, under your instructions dated March 5, 1906, and additional ones sent to Lesser Slave Lake in the following August.

I left Toronto March 8 for Edmonton, where my party was organized, and on March 20 we left for Lesser Slave Lake, where we arrived April 3.

The territory covered by my instructions, namely, that lying to the west of Lesser Slave lake, is composed of a rich soil varying in depth from 3 inches to 12 inches of black loam, upon clay subsoil generally, and lies with a gentle descent towards the east and south. It is very well suited to the purposes of agriculture, mixed farming or stock-raising. Large quantities of hay can be cut and made upon the flat country adjoining the lake, and the higher ground provides abundant pasture for stock on the prairie spots, and amongst the poplar and willow bush which in many places is quite open.

Lesser Slave Lake is now the distributing point for all freight which is required north and west as far as Fort Graham, Fort St. John, Fort Vermilion and Peace River district. As a result a certain quantity of oats is used by teams employed in the freighting business, and, except the small quantity used in stall feeding, there is no market for any more, at a profit. However, when once a railway is constructed, within any reasonable distance, there should be large quantities of oats, wheat, barley and vegetables of all kinds grown, which the soil is, in a high degree, capable of producing. Much speculation is indulged in, as to the future, with regard to the climatic conditions. Frosts occur every month, but this does not affect vegetation, especially that which has become acclimated. Grain and vegetables sown early in the season do not suffer, and ripen before the severe frosts come. Cultivation of the soil will change the climate, and after three years experience in that country my opinion is, that successful farming can be carried on in this district, but until there is an outlet for the produce there is not likely to be a large influx of settlers.

A settlement survey was made in the year 1901, which took in the greater portion of the prairie land surrounding the westerly end of Lesser Slave lake. Many of the lots so surveyed have had settlers living upon them at different times, but with the exception of those owned by the Roman Catholic and English missions, and three old settlers, nothing was grown that was for sale this year, there being no market for it.

The land adjacent to this settlement survey has been subdivided this season, and it is the general opinion that it will soon be occupied after a market has been established.

In addition to these lands, I subdivided township 74, range 16, and parts of townships 74 and 75, range 17, known locally as Prairie River Settlement. In order to do this the outlines of townships 73, ranges 16, 17 and 18 were surveyed. In townships 74 and 75, ranges 16 and 17, several settlers were found with good substantial improvements. This district is essentially farming land on account of the richness of the soil, while the excellent condition of the stock bears witness to the fattening qualities of the grass and peavine or vetch.

East and West Prairie rivers flowing from the southeast and southwest, join South Heart river flowing from the north, near the northeast corner of township 75, range 17. Each of these rivers flows in a channel about 100 feet wide and within banks from five to ten feet high. The water generally is shallow and seldom over a chain wide, but the sudden melting of the snow, or a two or three days' heavy rain causes the water to rise and almost fill each channel. Had each river an independent outlet to the lake, no flood would take place, but it is impossible for this extra quantity of water to escape through one outlet and the result is the overflowing at certain points, more particularly the north part of township 75 and the south part of township 76, range 16. This flooding is caused to a smaller extent at other parts of these rivers through the large quantities of driftwood becoming jammed, deflecting the water overland and around the obstruction until it again reaches the main channel.

The clearing of this driftwood out of the rivers will render the country alongside less liable to flooding and land now looked upon as valueless will become as good as the best.

There are two very good wagon roads between Lesser Slave lake and the settlements, but bridges will have to be built, to prevent the isolation of settlers for certain periods, at the time of flood, or of the formation and breaking up of the ice in the fall and spring.

The country adjoining the 19th and 20th base lines has been fully described in the reports of survey, and it may be well to add that in this part of the country, as in the most of the townships where bush predominates, conditions will greatly change when the land is cleared and cultivated.

Diligent inquiry and watchfulness failed to elicit any information regarding the proposed route of any railway except that of the Grand Trunk Pacific, which, being near Sturgeon lake, was out of my district.

The irregular boundaries of the several settlement surveys were traversed, and straight lines substituted therefor and permanently marked upon the ground.

Having completed this work I left for Edmonton, discharged my party and arrived in Toronto on the night of December 22, 1906.

I have the honour to be, sir,
Your obedient servant,

HENRY W. SELBY, *D.L.S.*

APPENDIX No. 42.

REPORT OF P. G. STEWART.

EXPLORATION OF THE COUNTRY WEST OF THE HUDSON BAY EXTENSION OF THE CANADIAN NORTHERN RAILWAY, TO THE PAS ON SASKATCHEWAN RIVER.

BRITANNIA BAY, ONT., Feb. 21, 1907.

E. DEVILLE, ESQ., LL.D.
Surveyor General,
Ottawa.

SIR,—On August 16, I left Etoimami, the Hudson bay junction on the Canadian Northern railway. After setting up our tents I gathered what information I could about the general character of the district I was sent out to explore. From what I could learn it was claimed to be very soft, marshes and muskegs being numerous, especially in the northern section. After getting this information, I considered it advisable to move into 'Thirtymile' creek, and examine the softest ground during the dry weather. Therefore we started by wagon on the right-of-way, following the sand ridge for twelve miles. This ridge is thickly wooded on both sides with small jackpine, poplar and spruce. We then left the right-of-way and followed the wagon road leading to the north for three miles when we arrived at Overflowing river, where we camped over night. Very hot day.

Aug. 17. This morning we crossed Overflowing river, when we turned east for two miles. We then came to the right-of-way again, and after following this up for two miles, we again turned to the north. The right-of-way here turned to the northeast going into Muskeg swamp; both sides are well timbered with spruce, jackpine, poplar, tamarack and some scattered white birch of no value, poplar being the prevailing timber. Marshes are numerous. One lake that I noticed, called Ruby, is half a mile wide and five miles long. These marshes are from half a mile to three miles long and from four hundred to six hundred feet wide, they contain water from one to four feet deep, and are surrounded with what they call water grass of no value for feeding purposes. At 2 p.m. we arrived at 'Twentymile' creek, about two miles west of the right-of-way. We passed through some very good spruce and tamarack with gaps of small poplar and jackpine. After taking lunch we proceeded for one and one-half miles. The ground is well timbered with spruce, poplar and jackpine on both sides, poplar being the prevailing timber, the others following in the order named. Marshes and muskegs still continued with gaps of alder, scrub spruce and tamarack of no value. At 7 p.m. we arrived at Fork creek where we camped over night. It rained nearly all day.

Aug. 18. We started at 6 a.m., going through some good large spruce, tamarack and jackpine and arrived at 'Thirtymile' creek at 2 p.m. The last four miles covered is all burnt and a second growth of poplar covers the ground in abundance. Turning east at this point and following down the south bank of the creek for three miles we arrived at the right-of-way again. Rained all forenoon.

Aug. 19. This morning we started at 6 o'clock, going west on the north side of 'Thirtymile' creek. This creek is twenty feet wide at the bottom, and runs in an easterly direction flowing at the rate of three miles per hour. It has an average depth of seven inches; the banks are six feet high and very steep. It would be a fine creek for driving logs. We went through some very large spruce, poplar and tamarack, spruce being the prevailing timber. At noon we passed out of the green timber and into the burnt country, continuing on for two miles through Muskeg swamp, timbered with small scrub spruce and poplar of no value. At 2 p.m. we arrived at the foot of Pasquia hills. After going up a very easy slope for half a mile the hills got very steep, with small poplar very thick. Continuing up for five miles we arrived at the summit about six or seven miles from the foot. On the north side of the valley of 'Thirtymile' creek, the water runs very swiftly. The valley is about six hundred feet wide and one hundred and fifty feet deep. For a long distance to the west, north and east, the country seemed to be all burnt and the Indian who was with us said the burnt district continued as far west as Carrot river. The day was cloudy and dull.

Aug. 20. This morning we travelled north on the top of the hills. Gullies are numerous and average from one hundred and twenty to one hundred and fifty feet deep and from two hundred to six hundred feet wide. In the afternoon we reached the timber again. Very hot day.

Aug. 21. This forenoon we came through some good spruce and tamarack but considerably scattered, tamarack being the prevailing timber. This afternoon spruce and tamarack continued, with openings of spruce and tamarack of no value. In the evening we arrived at the right-of-way. Very hot day

Aug. 22. This morning we went north between the right-of-way and the meridian line. After travelling for two hours through some spruce and tamarack we came to a small marsh of about four acres, covered with good hay. Passing through small spruce and tamarack for the next two hours, we came to good spruce and tamarack again. This afternoon we did not see much timber of any value, the ground gone over being mostly covered with small spruce, tamarack and brush. Very hot day.

Aug. 23. To-day I am examining the timber west of the meridian. We met with one marsh of about twenty acres, also one muskeg of about one hundred acres covered with brush and eight inches of water. This afternoon we saw considerable good spruce and tamarack. Fine day.

Aug. 24. To-day we travelled north of the timber examined yesterday and found considerable burnt country with small spruce and jackpine of no value. Fine day.

Aug. 25. To-day we moved eight miles north on the meridian line, and also travelled west toward the hills. Saw nothing but open muskeg. Big thunderstorm to-day.

Aug. 26. To-day we went west of the meridian line and encountered small poplar, very thick slash and windfalls, the whole country being muskeg, with two feet of water in places. In the afternoon we reached the top of the hills. The character of the ground is about the same as along 'Thirtymile' creek, gullies are numerous and from one hundred and twenty to one hundred and sixty feet deep and from three hundred to six hundred feet wide and very steep. The ground gone over to-day is burnt and timbered with small poplar of no value. Cloudy to-day, with high wind. Heavy frost last night.

Aug. 27. This morning we passed through large poplar, some spruce and some scattered white birch. Poplar is the prevailing timber. From the top of the mountains we could see a long distance; to the east the country is open with nothing but scrub spruce and jackpine of no value; there is also a large portion of it burnt. We also could see a long ridge of large timber to the north which seemed to be running in a northeasterly direction. We are meeting with some good spruce, but scattered. Poplar is the prevailing timber, there is also some good white birch and scattered balsam. Fine day.

Aug. 28. This morning we went west on the mountains. The timber was about the same as yesterday, with some muskegs from five to twenty acres wooded with small spruce of no value. The character of the ground was the same as yesterday, with gullies from one-quarter to one-half a mile wide and from one hundred and twenty to one hundred and seventy-five feet deep, but very easy of ascent. Fine, but very hot. Heavy frost last night.

August 29.—This morning, one hour after leaving, we came to the upper Pasquia river, which runs in an easterly direction through a large valley nine hundred feet wide and one hundred and forty feet deep, well timbered with large spruce and poplar, the latter being the prevailing timber. The bottom of the stream is sandy, with quite a quantity of boulders, and is thirty feet wide; it is very swift, and has an average depth of fourteen inches; the banks slope gently. We followed down the river on the south side. Large poplar and scattered spruce continued, with some balsam and white birch, very scattered. In the evening we reached the foot of the hills. Some rain to-day.

August 30. This morning we went east along the river. We found large poplar in abundance, with some small bunches of spruce and also some very large scattered trees. The belt of timber on the south side is half a mile wide and the trees are very large; the spruce is very scattered. Showery to-day.

August 31. This morning, half an hour after starting, we came to a bunch of jackpine half a mile wide by half a mile long. At 11 p.m. we reached the meridian line. Going north on the left side there is a small lake about half a mile long and about six hundred feet wide; the land is rolling on the south side, with some scattered jackpine and spruce of a good size. On the west side is a small jackpine plain, and on the southwest side is an alder swamp that seems to extend to the hills. We followed the river for three miles and crossed the meridian line nine times inside of a mile. There is some very large spruce, but scattered; also poplar in abundance, with considerable white birch of a good size. I am going to examine the country west of the meridian through to Carrot river. To-night we are about the northeast corner of township 51. Cloudy, with wind.

September 1. This morning we went west towards the hills. The ground along both sides of the meridian at this point is covered with small jackpine of no value; for two miles north and south, and for two and one-half miles east and west, the land is sand, with some granite boulders. At one mile west of the meridian and one mile north of Pasquia river there are three small lakes surrounded with brush. After leaving these lakes to the east about half a mile we came to a swamp covered with scrub spruce for half a mile, then with good spruce and poplar for two miles to the foot of the hills. The timber increased in size, poplar still being the principal variety, with some scattered birch and balsam, and some muskegs covered with scrub spruce. The hills were very easy and rolling. Fine day.

September 2. This morning we continued westward. Some spruce and poplar of a good size were still in evidence. Before noon we reached the top of the hills and, turning north, we travelled on the hills about four miles. Poplar is the prevailing timber. We crossed a marsh one mile by one and one-half miles wide, covered with good hay. Fine day.

September 3. We travelled east to-day, descending the hills. The timber on the face of the hills is principally poplar, with some scattered spruce and birch. All afternoon we went through a heavy growth of spruce. Cloudy, with high wind.

September 4. This morning we passed out of the spruce into a tamarack swamp. Considerable of the timber in the swamp is dry, but sound; the green timber is large. The extent of the swamp is about one by one and one-half miles. A great many railway ties could be made here. Cold and cloudy.

September 5. We travelled east this morning to the meridian. Good spruce was still plentiful. On reaching the meridian we travelled north along the east boundary of township 52, range 1. Both sides were well timbered with large spruce, scattered balsam and large poplar. Bright and cold.

September 6. To-day we went west on township 52. There was an abundance of spruce and tamarack all forenoon. At 11.30 we came to a muskeg about twenty acres in extent, covered with small spruce of no value. After passing this muskeg we came to good spruce. During the afternoon we passed out of the thick spruce into some scattered spruce and large poplar, with abundance of white birch. Very hot day.

September 7. This morning we continued westward. Gullies are numerous, from fifty to two hundred feet wide and from fifteen to forty feet deep, steep in some places and in others with easy slope. At noon we turned north. Scattered spruce, poplar and white birch continued. We came to a small lake surrounded with birch and scattered spruce. A small creek runs out of this lake. I could see a long distance to the east. From the foot of the hills the country was all open muskeg, with numerous small lakes. By 8 p.m. we had come north about eight miles. Poplar and spruce continued; the spruce was very scattered and the poplar large and plentiful, with abundance of white birch. Rained hard all day.

September 8. This morning we reached the highest point on the hills. There is a sand bank here about thirty feet above the general level and half a mile long, with an almost perpendicular slope. I could see an abundance of large spruce and jackpine to the west and the valley of Carrot river to the north. At 2 p.m. we descended from the north end of mountains. Large spruce was plentiful, with considerable large balsam. Cloudy and dull.

September 9.—We continued northward this morning. The slope of the hills was very easy and well wooded with spruce, poplar and some scattered balsam and birch. At 4 p.m. we came to the south bank of Carrot river, which is about two hundred and twenty feet wide with banks fifteen feet high and very steep; it seems to be pretty deep. Quite a number of Indians were camped on the north side. On going down the north side we found considerable large spruce and poplar, but somewhat scattered. Some rain to-day.

September 10.—This morning we went north towards Saskatchewan river. By noon we had found no timber of any value, the country being all swamp and marshes with considerable good hay. The Indians say there is no timber between Carrot and Saskatchewan rivers in this space. Cold and windy.

September 11.—We got back to Carrot river at 9 o'clock last night; to-day we travelled down the north side of the river. Quite a quantity of large spruce was encountered, but considerable of it has been blown down. I saw at least 12,000,000 feet of spruce to-day that will average one hundred feet for lumber and about 2,500,000 for pulp; also 6,000,000 feet of poplar that will average ninety feet for lumber and about 1,500,000 for pulp. Geese and ducks were very plentiful. Fine day.

September 12.—This morning we made a float and crossed to the south side. Travelling westerly we found poplar in abundance and some large but scattered spruce. Half a mile south the country is marsh and muskeg swamp covered with scrub, spruce brush and some hay. At noon we came to a large space with considerable large poplar. By night we reached the meridian. We saw to-day about 7,000,000 feet of spruce for lumber that will average ninety feet to the tree and 2,000,000 feet for pulp; the poplar will average seventy feet to the tree with about 8,000,000 feet for lumber and 2,500,000 for pulp.

The following statement is an estimate of the timber I have examined north of 'Thirtymile' creek and west of the second meridian. I consider I have gone over ten miles by twenty-four miles, and a total of two hundred and forty square miles. Taking one hundred and forty miles out for waste land and bad timber, we have left one hundred miles of standing timber divided as follows. I have measured in different places 74 acres and found the average dimensions as follows:—

Spruce suitable for lumber (dimension 56 ft.)	24,000,000	ft. B.M.
Spruce suitable for pulp	40,000,000	"
Total	64,000,000	"
Poplar suitable for lumber	100,000,000	"
Poplar suitable for pulp	15,000,000	"
Total (dimension 90 ft.)	115,000,000	"
Tamarack for lumber (dimension 46 ft.)	9,000,000	"
Balsam suitable for lumber (dimension 40 ft.)	2,000,000	"
Balsam suitable for pulp	4,000,000	"
Total	6,000,000	"
Jackpine for lumber (dimension 42 ft.)	4,000,000	"
Jackpine for pulp	5,000,000	"
Total	9,000,000	"

	Ft. B.M.
Spruce	64,000,000
Poplar	115,000,000
Tamarack	9,000,000
Balsam	6,000,000
Jackpine	7,000,000
White birch	6,000,000
Total	207,000,000

September 13.—To-day we went south on the meridian. Marshes, muskegs and small lakes were numerous. We reached the southeast corner of township 53, this evening, and saw no timber of any value to-day, with the exception of one small spruce ridge containing about 1,000,000 feet suitable for pulpwood. Fine day.

September 14 and 15.—The last two days I have been travelling east of the meridian and east of township 52. Shortly after starting yesterday morning we passed a small lake surrounded with long weeds and scrub spruce, one mile wide and one mile long. Continuing south and east I found spruce and large scattered poplar with openings of scrub spruce and tamarack. During the last two days we have measured twelve acres in different places, and found the average dimension of spruce sixty-four feet, board measure, to the tree, or a total of 8,500,000 feet for lumber and about 2,000,000 feet for pulp. The average dimension of the tamarack is fifty feet B.M. to the tree, or a total of 4,500,000 feet. A great many tamarack railway ties could be made here. The average dimensions of the poplar is one hundred and twenty feet to the tree or a total of 15,000,000 feet B.M. for lumber and 2,000,000 for pulp. Raining hard the last two days. We carried no tents, as they were too much to carry through the country with little help.

September 16.—This forenoon at 9 a.m. we reached Pasquia river, about five miles east of the meridian. The river at this point runs in an easterly direction and is thirty-five feet wide with steep banks about twelve feet high, has an average depth of 14 inches of water, and runs very swiftly. I could see for a long distance south and east, a low swampy country, covered with brush; we followed down the north bank for three miles, when we came to a lake through which the river runs. On the north side of the lake we came to spruce timber. Showery to-day.

September 17.—I have been examining this spruce to-day. I measured four acres in different places and found the average dimension of trees to be sixty-one feet, or a total of 6,200,000 feet B.M. for lumber and about 2,000,000 feet for pulp. Dimension of poplar seventy-eight feet, 3,000,000 feet B.M. for lumber and 1,500,000 for pulp.

September 18.—Going east towards the railway the country is open, low and swampy with brush and windfalls.. At 3 p.m. we came to Little Pasquia river and reached the railway at 5 p.m. The last four miles is low and wet, covered with scrub spruce and moss. Continuing north on the railway, the country is all swamp with the exception of a few low jackpine hills. We are camped to-night four miles south of Seventy-mile store. Cloudy and dull.

September 19.—To-day we travelled on the right-of-way to The Pas. On our left a narrow strip of poplar and spruce was seen. The land was rolling with ridges eight to fifteen feet high, and from fifty to fifteen hundred feet wide. Between the ridges are muskeg swamps, which continue for sixteen miles. For the last two miles the land is sandy and covered with small poplar and jackpine of no value. The dimension of the spruce is about forty-five feet with a total of 1,500,000 feet B.M. for lumber. The spruce suitable for pulp would measure about 3,000,000 feet. The dimension of the poplar is about fifty-five feet with a total for lumber about 2,000,000 feet, and for pulp about 5,000,000 feet. Rained all day.

September 21.—We left The Pas by canoe, going up Pasquia river. The stream for three miles is two hundred feet wide and has a depth of three feet of water; the banks are from six to eight feet high and very steep, and are covered with a strip of small willow brush. Outside of this, the land is low and covered with rich grass, in which we saw countless geese, also black and other ducks; in fact this seems to be a sportsman's paradise. About half a mile farther up the stream it runs very swiftly, with about four inches of water and very soft bottom. Most of the distance for another mile was made by poling, the current being too swift and strong to be overcome by paddling. The banks along here are about fifteen inches high; for two hundred acres on each side the country is very level with not a spear of grass or anything growing. Near the lake the river is two hundred feet wide but very shallow. The land on both sides is very low and covered with rich grass for one mile wide on the east side and as far as I could see on the west. The river for the next ten miles is a beautiful stream, the banks on each side being covered with a narrow strip of willows. At 3 p.m. we arrived at 'Seventy-mile' store. The river at this point is half a mile west of the right-of-way. Continuing up stream this afternoon the country had the same characteristics as the lower tract, except that the poplar on the north side is somewhat larger. Fine day.

September 22.—This morning I crossed to the east side and travelled between the river and the right-of-way. The country is very low and swampy. Continuing towards the right-of-way we came to a strip of good spruce, poplar and tamarack. This strip of timber crosses the right-of-way about six miles north of 'Fiftymile' store and seems to continue east for a good distance. The ridge on the west side is half a mile wide and three miles long. I measured four acres in different places and found the average dimension of spruce trees to be sixty-three feet with a total of 1,500,000 feet B.M. for lumber and about 1,000,000 feet for pulp. The average dimension of the tamarack is forty-nine feet to the tree, and a total of 275,000 feet B.M. The poplar is scattered and will average per tree about eighty feet and a total of 800,000 feet B.M. for lumber. Fine day.

September 23.—This morning half an hour after starting we crossed a big floating muskeg for two miles, with water to the knees. At 9 a.m. we came to a lake about one mile wide and one and one-half miles long, surrounded with small spruce and poplar. Continuing south we came to a spruce and jackpine ridge and on travelling around it I found it contained an area of about four hundred acres. I measured four acres in different places, and the average dimension of the spruce was forty-five feet to the tree with a total of 1,000,000 feet B.M. for lumber and about 600,000 feet for pulp. The average dimension of the jackpine was forty-eight with a total of 700,000 feet B.M. for lumber and 300,000 feet for pulp. On crossing a long narrow floating muskeg to the southwest we came to another small ridge of spruce and jackpine, about two hundred and fifty acres in extent. I measured two acres and found the average dimension of spruce trees to be fifty feet and a total of 1,000,000 for lumber, 400,000 for pulp. The average dimension of the jackpine was fifty-two feet with a total of 600,000 feet B.M. for lumber and 300,000 for pulp. At 1 p.m. we reached the east bank of Little Pasquia river and turned northeast. In the afternoon we reached Pasquia river. The poplar along both sides is plentiful but small, with considerable good but scattered spruce. Fine day.

September 24.—This forenoon we travelled on the north side of the river where there is considerable large spruce and poplar. It is impossible to travel in this district as it is low land and almost covered with water. I have decided to leave it until we get frost. At 2 p.m. we arrived back at the river. Going along the south bank we passed through poplar with gaps of alders and low swampy land to the left. The dimension of the spruce is about fifty feet with a total of 500,000 for lumber with 500,000 for pulp. The dimension of the poplar is about forty feet or a total of 4,000,000 feet for pulp. At 5 p.m. we arrived at the mouth of Little Pasquia river. At this point the main river makes a decided bend to the north, and as the course is fairly straight a charming vista is open to our view; the peaceful, winding river is fringed with meadows of tall grass, and bounded on either side by a good spruce ridge. This afternoon we went up Little Pasquia river. The banks are well timbered on both sides, but with only a narrow strip of spruce, poplar and some jackpine. The land is rolling; the hills will average about twenty feet high, very steep in some places and easy in others. The valleys are from fifty to two hundred feet wide. The river for five miles up from the mouth is fifty feet wide, with high and very steep banks. The water is running about two miles per hour, and has an average depth of eight inches. Cloudy, with strong west wind.

September 26.—Half an hour after starting this morning we came to rapids with very little water. These rapids are from one hundred to five hundred feet in length and continue with gaps of steady water up to the right-of-way, a distance of about ten miles. The bottom consists of small round stones, with very few boulders of any size.

At twelve o'clock we came to a strip of burnt timber about one-half mile wide. To-day we examined the strip of timber along both sides of the river and found that the strip will average about two hundred feet wide, on each side, with gaps of alders and several small creeks coming in on the west side. Outside this strip of timber the land is low and swampy and there is no timber of any value. The river can be made into a good stream for driving logs by building a dam above the railway bridge. It is about fifteen miles from the mouth up to the railway. The dimension of the spruce is about fifty-five feet to the tree and a total of 3,000,000 feet B.M. for lumber and 4,000,000 feet for pulp. The dimension of poplar is sixty-five feet B.M. and a total of 2,000,000 feet for lumber, and 1,500,000 feet for pulp. Jackpine is very scattered and has a dimension of about forty feet, with 300,000 feet B.M. for lumber, and 300,000 feet for pulp.

September 27.—To-day we went down the right-of-way. Both sides are low and swampy. For a distance of five miles south of Little Pasquia it is all open muskeg. We arrived at Thirtymile creek at 8 p.m. We saw no timber along the line to-day of any value. There are deposits of limestone in several places along the right-of-way, between Thirtymile creek and Fiftymile creek. It seemed to be all in small boulders and some of the railway men informed me that it was of no value.

ESTIMATE OF STANDING TIMBER EAST OF THE SECOND MERIDIAN AND NORTH OF THIRTYMILE CREEK AND SOUTH OF PASQUIA RIVER TO THE PAS.

I have measured forty-one acres in different places and found the dimensions as follows:—

	Feet, B.M.
Spruce suitable for lumber, average 55 feet, total......	23,200,000
Spruce suitable for pulp, average 55 feet, total	13,000,000
	36,200,000
Poplar suitable for lumber, average 95 feet, total......	22,800,000
Poplar suitable for pulp, average 95 feet, total......	14,000,000
	36,800,000
Jackpine suitable for lumber, average 50 feet, total	1,600,000
Jackpine suitable for pulp, average 50 feet, total	900,000
	2,500,000
Tamarack suitable for lumber, average 50 feet, total..	4,775,000
Total........................	80,275,000

All the land gone over is low and swampy, with the exception of Pasquia hills, which are all sand. I saw no land of any value for agricultural purposes north of Thirtymile creek.

September 28.—Some frost last night. Travelling south from Thirtymile creek we came to a strip of large spruce and poplar about one-quarter of a mile wide and extending back west about three miles. There is also considerable small spruce suitable for pulp wood. For one mile west of the right-of-way the land is level, and for the next two and one-half miles the land is rolling with gullies about eight feet deep and five feet wide. At three miles from the right-of-way is the north end of the sand ridge that extends to Etoimami. South of this strip of timber there is a strip of burnt timber about one and one-half miles wide. Passing over this, we came to jackpine, spruce and poplar in abundance. At 10 a.m. we came to a large creek running to the east, with a current of six miles an hour. This creek is thirty feet wide and has an average depth of six inches of water. Its banks are three feet high and extend back for fifty feet, where they rise to a height of thirty feet and are very steep. The bottom is gravel and it can be made a good stream for driving timber with very little expense. The Indians say this stream is a continuation of Little Pasquia river. Going up the stream for another one and one-half miles, large spruce and poplar is plentiful with some scattered balsam of a good size. Fine day.

September 29.—To-day we followed up the creek. The land is very low, swampy and burnt, with scattered large spruce and balsam. About 9 a.m. we came to the foot of Pasquia hills. The country rises at an easy slope for one-quarter of a mile, is very level for the next one and one-half miles, and then gets much steeper for the next two miles. Here the gullies are about one hundred feet deep and four hundred feet wide and are very numerous. The sides are very easy of ascent and are wooded with small poplar in abundance, but of no value. The river runs through a very large valley six hundred feet deep and two thousand feet wide, with gently sloping sides. Cloudy and dull.

September 30.—Some frost last night. This forenoon we went south on hills for about five miles. The character of the ground was much the same as that gone over yesterday. This afternoon at 1 p.m. we turned east and descended the hills. Going down at easy slopes we reached the foot at 5 p.m. It is very low, wet swampy land, well timbered with spruce and poplar, spruce predominating. Fine day.

October 1.—This morning about one hour after starting we passed out of the spruce and tamarack which continued. We next came to a big marsh about one mile by four miles. This marsh contains considerable water and is covered with water grass. For the next two miles the ground is well timbered with spruce, poplar and some tamarack. Passing out of the timber we came to a marsh about half a mile by one mile, also containing water and water grass. Following for six hundred feet down the creek, which runs out of the marsh, we came to another creek coming in from the southwest. We came also to the sand ridge and wagon road. The ridge is twenty feet high and six hundred feet wide, and is well timbered with large spruce. The timber continues to the right-of-way, a distance of about two miles. This creek is twenty feet wide and has banks four feet high which slope gently. The average depth of water is four inches and the current is six miles an hour. Cloudy and dull.

October 2.—We travelled three miles north this morning on the right-of-way and found spruce and poplar plentiful. Turning west and following up the creek we went for three miles and found abundance of spruce and poplar. At noon we reached the sand ridge and wagon road. At 12.30 we started south on the wagon road and continued for four miles. Both sides were well timbered with large spruce and poplar, and some jackpine. At 4 p.m. we left the wagon road and travelled west. The land was low and swampy with ridges of spruce, poplar and jackpine and open spaces covered with scrub spruce and tamarack. Some rain to-day.

October 3.—At 8 a.m. we reached the foot of the hills. The hills are steep and wooded with scattered large spruce and poplar. The poplar does not look to be very sound. We felled three trees ; two were twenty-four inches and one twenty-five inches at the butt. We found them very rotten at the top and shaky at the butt. Continuing we found the hills very steep and covered with brush so thick that it was almost impossible to get through. At noon we reached the top and found spruce and poplar, scattered and not very healthy looking. A large area of the hills here is burnt. Continuing west we found the spruce more plentiful and larger. At 3 p.m. we came to burnt country, and as far west as I could see it is all small jackpine, of no value. Turning south and going through the small jackpine for the next three hours we came to a very large valley four hundred feet deep and 3,000 feet wide. The land is sand with a great many large land slides. Letting ourselves down the bank we found a creek running to the east. It is twenty-five feet wide, with an average depth of seven inches of water and a rapid current.

October 4.—This morning we climbed up the south bank. It is wooded with scattered spruce, poplar and white birch. Going west on the south side we found considerable spruce and large poplar ridges, and a large portion of the country burnt. The land is pretty level. We crossed a few gullies about fifty feet deep and four hundred feet wide. They were steep and timbered with small poplar of no value. At 6 p.m.

we came to a muskeg where we camped for the night. Some light showers to-day. Moose very plentiful.

October 5.—This morning going east we crossed one gully about 175 feet deep and 500 feet wide. The slope was pretty steep and it was wooded with small poplar and spruce of no value. At 9 a.m. we came to open sand plains, with ridges of large spruce and poplar. At 5 p.m. we came to the creek we crossed yesterday morning running in a southeastern direction. The valley of the creek here is about 40 feet wide at the bottom, and two hundred feet deep and very steep. The creek is about the same size as where we crossed it farther west, but it does not run so swiftly and has a sand bottom. Rained hard all day.

October 6.—At 9 a.m. we reached the foot of the hills. The land is level but low and swampy, with some good spruce and poplar. At 12 o'clock we were in spruce in abundance. We then crossed two open muskegs of about fifty and seventy-five acres respectively, and covered with moss, small spruce and tamarack of no value. At 6 p.m. we were still in the spruce. Rained all day.

October 7.—This morning we passed out of the spruce into a very wet small spruce swamp one mile wide. We next came to an open swamp about half a mile by half a mile, covered with moss, with large spruce and poplar on our right and left. At 2.30 we came to a sand ridge wooded with small poplar and scattered large spruce. The ridge is 10 feet high and 600 feet wide. The east slope descends into a swamp wooded with tamarack and scattered spruce. Still going east the land is low and swampy for one mile. We reached the right-of-way at 5 p.m. The last mile was well timbered with spruce. Some rain to-day.

October 8.—Snowed all day. Remained in camp.

October 9.—This morning we went south on the right-of-way. The timber is small spruce and poplar, suitable for pulpwood. At 9 a.m. we came to Twentymile creek. Going west up the right bank we found the poplar and spruce very scattered, but on the left bank it was very large and plentiful. Proceeding for one and one-half miles we came to a sand ridge about half a mile wide with easy slopes. The creek is thirty feet wide. Its banks are very low on the north side and on the south side they are about 6 feet high with easy slopes. The creek has an average depth of 8 inches of water and runs very swiftly; the bottom is small boulders and gravel. It is a good stream for driving timber. Cloudy, with west wind.

October 10.—This morning we followed up the creek on the right bank. We found large jackpine very plentiful for one mile. Following up the stream for three miles we came to the forks. Proceeding up the right branch we found large spruce and poplar were very plentiful, with spruce predominating, also hazel brush very thick and hard to get through. At 12 o'clock we were still in the spruce. At 4 p.m. we passed out of the thick spruce, and into scattered large spruce and poplar, with poplar predominating. Following up the creek we found the hills on each side about one hundred and fifty feet high very steep on the south side, and easy on the north side, and about ninety feet wide at the bottom. Fine day.

October 11.—We climbed up the south bank this morning and went west for one mile through burnt timber, with scattered ridges of large spruce and poplar. Proceeding southwest for two miles we came to a marsh covered with brush. Crossing the marsh to the southwest we came to large poplar and spruce, poplar being the prevailing timber. The land is level and sandy and has also much small poplar, which, however, is of no value. We next crossed three open muskegs of about five, ten and twenty acres respectively. The land covered to-day is burnt in many places. Fine day.

October 12.—This morning we travelled west for four miles. It is nearly all burnt country, with some scattered spruce and poplar. At 4 p.m. we came east crossing some gullies, from twenty-five to one hundred feet deep, and from one hundred to six hundred feet wide with easy slopes. These gullies are wooded with small poplar and scattered large spruce. Fine day.

The timber area north of Twentymile creek and south of Thirtymile creek is not over five miles.

	Ft. B.M.	Ft. B.M.
		Dimension 56 ft.
Spruce suitable for lumber	9,000,000	
Spruce suitable for pulp	10,000,000	
		19,000,000
		Dimension 78 ft.
Poplar suitable for lumber	15,000,000	
Poplar suitable for pulp	10,000,000	
		25,000,000
		Dimension 50 ft.
Jackpine for lumber	4,000,000	
Jackpine for pulp	3,000,000	
		7,000,000
		Dimension 45 ft.
Tamarack for lumber		1,000,000
		Dimension 40 ft.
Balsam for lumber	200,000	
Balsam for pulp	300,000	
		500,000
Total		52,500,000

October 13.—One hour after starting this morning we came to the south branch of Twentymile creek. It runs a little north of east and is about the same size as the west branch. It has an average depth of eight inches of water, the current is swift and it is a good creek for driving timber. The valley is about one hundred and twenty-five feet deep and pretty steep, and is about seventy feet wide at the bottom. The valley is wooded with scattered spruce, poplar and some birch. The country for the next six miles is timbered with poplar and scattered spruce. Showery to-day.

October 14.—At 8 a.m. we reached the summit of the mountain. From there we could see a large green country to the east, seeming to extend for some distance east of the railway line. We could also see a lake about twelve miles to the southeast. I presume this is Leaf lake. It is surrounded for a great distance with large timber. Descending the mountains through large spruce and poplar for one mile we came into large jackpine for another mile. Still following down the stream we found the country well timbered with large spruce. At 2 p.m. we came to a fork. From there we went southeast for two hours through good sized spruce and poplar with gaps of open muskeg covered with scrub spruce and tamarack. We reached the sand ridge and wagon road at dark. Some rain to-day.

October 15.—The sand ridge here is five hundred feet wide and twenty feet high, and is wooded with small spruce and poplar suitable for pulpwood, also some jackpine of no value. After leaving the ridge large poplar is plentiful, with some good sized spruce and tamarack. The poplar extends to the right-of-way, a distance of about two and one-half miles. We went south on the right-of-way for three miles and found it timbered with scrub spruce and tamarack. Fine day.

October 16.—Going west this morning for one and one-half miles through swamp and scrub spruce, we came to a tract of country about one and one-half miles in extent covered with spruce, large and plentiful. Continuing we came to a jackpine ridge about five hundred feet in width wooded with small timber suitable for pulpwood, after this we came to large spruce again for another mile and reached the same ridge and wagon road at 5 p.m. Fine day.

October 17.—This morning after crossing a marsh covered with water grass and containing twenty inches of water we came to large spruce again in abundance for three miles. We then crossed a small open muskeg for one-quarter of a mile, and came into country covered with scattered spruce with considerable poplar. This lasted for about a mile till we came to the foot of the hills. Fine day.

October 18.—Proceeding west this morning we went up hills with a gentle rise. The poplar was plentiful with scattered large spruce and very thick hazel brush. Continuing for two hours, at 9 a.m. we reached the top of the hills, which were covered with large spruce and poplar. At noon we came to an alder swamp with a small stream running south. At 5 p.m. we came to a muskeg covered with scrub spruce. Continuing we passed through large spruce in bunches and scattered poplar. The land covered this afternoon was level and swampy. Fine day.

October 19.—Going west this morning for one mile through a small spruce swamp, we came to a burnt country with scattered ridges of good large poplar. Spruce is not very plentiful. At noon going south for three miles we crossed three steep gullies with an average of 75 feet in depth and 450 feet in width. At 10 a.m. we came to the west branch of Overflowing river, running in an easterly direction and very steady. The river is 20 feet wide and the water is 15 inches deep. The valley is 40 feet deep and 400 feet wide and has easy slopes which are timbered with scattered spruce, poplar and some white birch. We crossed over to the south side and went through scattered spruce and poplar for two miles. A great deal of the land has been burnt over. We came to the south end of the mountain, and from there could see a long distance to the south and west. Marshes and muskegs are numerous. At 4 p.m. after going east on the top of the mountain for two miles we came to the west branch of Overflowing river again. Fine day.

October 20.—Going east this morning we found the brush hard to get through. The spruce and poplar is large but scattered. At 2 p.m. we descended from the mountain. The mountain side was rolling and had an easy slope. The valley of the river is not so large as it is farther west. We reached the foot of the hills at dark.

October 21.—This forenoon we followed a large spruce and poplar ridge. On the south is a big alder swamp. At noon we came to the forks. The east and west branches are about the same size. The main stream below the forks is 40 feet wide. The banks are 15 feet high and very steep. The water is running at the rate of four miles an hour and has an average depth of 2 feet. This afternoon we went in a northeasterly direction. For the last two miles we met with scattered large spruce and poplar. At 2 p.m. we came to a swamp half a mile in extent and covered with considerable water. We then came to a burnt country; the land is level and sandy. Wolves are numerous. Fine day.

October 22.—One hour after starting this morning we came to an open muskeg, with 8 inches of water and extending for two miles. We then came to a sand flat three miles in extent and covered with small poplar of no value. At 5 p.m. we came to Overflowing river, two miles west of the right-of-way. The river along here is flat rapids, with an average depth of 10 inches of water. The bottom is very stony with a considerable quantity of large boulders. It is a good river for driving timber. At 5.30 we reached the sand ridge and wagon road. The ridge here is 1,000 feet wide and 25 feet high, and is timbered with scrub, poplar and jackpine. The bank of the river is 15 feet high and is very steep. Fine day.

October 23.—We reached the right-of-way at 8.30 a.m. There is no timber of any value between the right-of-way and the wagon road. We went south on the right-of-way for three miles, then turned west and crossed a marsh at the north end of Ruby lake covered with water grass and considerable water. After crossing the marsh we came to small poplar, which continued for four miles. We then came to another marsh which is about one mile by three miles and is covered with brush and water grass. Then for two miles spruce was very plentiful and following this came a big muskeg three miles by four miles, covered with moss and with water to the knees. Going from there in a northwesterly direction we came to the south fork of Overflowing river, about one mile west of the forks. We also came to the new limit line, running east and west. Going up on the south bank of the river, we found spruce and poplar very plentiful for two miles, the last mile being chiefly spruce. After this we came to a muskeg two miles by three miles covered with moss and scrub spruce, and surrounded by ridges covered with scattered large spruce and poplar. Fine day.

October 24.—We continued up the south bank through spruce and poplar for four miles. After going for three miles the timber became very scattered and here the river takes a decided bend to the south. We went on for two miles more and continued to find scattered spruce and poplar. Fine day. The timber area south of Twentymile creek and north of Overflowing river is about eight miles square.

	Ft. B.M.	Ft. B.M.
		Dimension 60 ft.
Spruce suitable for lumber	15,000,000	
Spruce suitable for pulp	9,000,000	
		24,000,000
		Dimension 100 ft.
Poplar suitable for lumber	20,000,000	
Poplar suitable for pulp	15,000,000	
		35,000,000
		Dimension 40 ft.
Jackpine suitable for lumber	1,500,000	
Jackpine suitable for pulp	2,000,000	
		3,500,000
		Dimension 40 ft.
Tamarack suitable for lumber		2,000,000
		64,500,000

October 25.—This morning we crossed to the west side of the river. The water is 3 feet deep and very steady ; it is 25 feet wide; the banks are 15 feet high and very steep. Continuing west we passed a small lake to the east, one mile by one and one-half miles, surrounded with good hay, and with a spruce ridge to the north. Going west the timber continued all afternoon. The ground covered to-day is low and swampy. Fine day.

October 26.—We travelled west to-day through groves of spruce, scattered poplar and opening tracts of scrub spruce and tamarack. The ground covered to-day is swampy and wet. At 5 p.m. we came to an open muskeg with eight inches of water, and covered with scattered scrub spruce. Fine day.

October 27.—We went south this morning through scattered spruce and poplar and considerable spruce. At 10 a.m. we came to the south branch of Overflowing river again. Both sides are covered with alder for a space of one thousand feet. The banks are twenty feet high and very steep. The stream is twenty feet wide and has an average of six inches of water and a current of two miles an hour. At 11 a.m. from the south side of the river, we went east through spruce and poplar. Poplar was the prevailing timber to-day. Land low and wet. Fine day.

October 28.—We went east this morning through country where spruce and poplar is plentiful with some scattered tamarack. We crossed three muskegs having an average of twenty acres each. The land is low and swampy. At 6 p.m. we reached Ruby lake about the centre on the west side. For the last two miles the spruce is thick, but not very large. Snowing and wet all day.

October 30.—We came to Etoimami and stayed there as it snowed and rained all day.

October 31.—We went west along the railway for twelve miles. The land was all swamp and the timber was principally poplar with some spruce and scattered tamarack.

At 4 p.m. we were going north through a low swamp with water six inches deep, and broken by small poplar ridges. The spruce is very scarce; some has been cut. Cloudy and cold.

November 1.—Going west this morning we crossed a creek running in a south-easterly direction. I presume it is Fir river. It is fifty feet wide, has banks from eight to ten feet high, an average depth of ten inches of water, and a current of four miles an hour. Going east through scattered poplar and spruce for two miles, we came to a marsh surrounded with good grass and containing fifteen inches of water. Cloudy and cold.

November 2.—We travelled to-day in a northeasterly direction through thick poplar and small spruce. We crossed two muskegs covered with water and moss to the knees. The country covered to-day is low and swampy, and much the same as that covered yesterday. It is fairly well timbered with poplar, some scattered spruce and a great quantity of small stuff of no value. At 5 p.m. we reached Etoimami.

Estimated quantity of standing timber south of Overflowing river and north of Etoimami:—

	Ft. B.M.	Ft. B.M.
		Dimension 54 ft.
Spruce suitable for lumber	10,000,000	
Spruce suitable for pulp	15,000,000	
		25,000,000
		Dimension 59 ft.
Poplar suitable for lumber	15,000,000	
Poplar suitable for pulp	20,000,000	
		35,000,000
		Dimension 40 ft.
Tamarack suitable for lumber		5,000,000
		Dimension 36 ft.
Balsam suitable for lumber	2,000,000	
Balsam suitable for pulp	3,000,000	
		5,000,000
		Dimension 32 ft.
White birch suitable for lumber		1,000,000
		71,000,000
Total estimate north of Thirtymile creek and west of meridian line		207,000,000
Total estimate north of Thirtymile creek and east of meridian line and south of Pasquia river		72,975,000
Total estimate north of Etoimami and south of Overflowing river		71,000,000
Total		350,975,000

November 3-21.—We were unable to proceed with the work until it froze up. During part of this time I had leave of absence. The rest of the time was spent on the journey to and from home.

November 22.—We left Etoimami by train, on The Pas extension of the Canadian Northern Railway. Snowing and cold.

November 23.—We arrived at Thirtymile creek at 10 a.m. After lunch, we started north and followed the 2nd meridian line for three miles, where we camped over night. Very cold.

November 24.—To-day we went about seven miles. The snow is three feet deep, and there was quite a number of trees across the line. Very cold east wind.

November 25.— We went about eight miles to-day and camped on the bank of a stream they call Cross creek, about the northeast corner of township 53. Very cold.

November 26.—Cross creek is about fifteen feet wide, has an average depth of three feet of water, and is very steady. This stream runs in an easterly direction and flows into Pasquia river about two miles east of the meridian line. The banks are three feet high and slope gently. To-day we went west up the creek. The banks are well timbered on each side with spruce and some tamarack. On the left, outside of the ridge of timber, which is about four hundred feet wide, is a marsh one-quarter of a mile wide by three-quarters of a mile long. On the south side of the marsh, spruce and poplar are very plentiful. Continuing up the creek we came to three marshes, one extending to the north for six miles and about one-quarter of a mile wide. It is covered with brush, and is wooded on the west side with small tamarack. On the east side the tamarack is still smaller, with open muskeg and scrub spruce. The other two marshes are floating muskegs covered with moss. These marshes are about two miles west of the meridian line. This afternoon we went east on the north side of Cross creek. We went through open muskeg and scrub spruce, and passed several small lakes, reaching the meridian line at dark. Snow three feet deep. Very cold.

November 27.—This morning we went east on the meridian line for two miles and then leaving the line we turned west. We found spruce, poplar and tamarack very plentiful. At noon we reached the foot of Pasquia hills, and went up the mountains for two miles. The ground rose gradually and is covered with spruce in abundance, and considerable large balsam. We went north for the next hour, over some small gullies about 8 feet deep and 30 feet wide, with easy slopes. At 4 p.m. we came to a small creek and camped. This creek is a continuation of Cross creek, and runs through the long marsh running west, two miles west of the meridian line. The valley is 6 feet wide at the bottom. The banks are 8 feet high and very steep. It contains no water. Spruce and balsam are very thick, with scattered poplar and white birch. Bright and cold.

November 29.—We came east to-day on Cross creek. Spruce was very plentiful on each side. There was also some scattered tamarack. At 10 a.m. we came to Pasquia river, about two and one-half miles east of the meridian line. Timber can be driven down Cross creek from the marshes for about four and one-half miles. We went up Pasquia river for four miles. There is a narrow strip of spruce along each side. Here the creek gets very narrow and its banks are densely covered with willow brush. Outside this strip of timber is low swampy land covered with alder and some hay. Very cold with east wind.

November 30.—We went east to-day, through low swampy land, covered with brush and scattered spruce. At 11 a.m. we came to another creek, running in a northerly direction. This creek is 15 feet wide. The banks are 5 feet high and slope easily. We followed this stream up for half a mile, through some scattered spruce on each side. It then gets very narrow and the banks are covered with brush. Turning back we followed the stream down for two and a half miles. For three-quarters of a mile the banks are well timbered on each side with spruce and tamarack. I have measured eight acres in different places, and found an average of 48 feet to the tree for spruce with 4,000,000 feet for lumber and 3,000,000 for pulp. Tamarack averages 42 feet to the tree with 1,500,000 feet B.M. for lumber. Bright and cold.

December 2.—We went north to-day. It was all open country and we saw no timber of any value. Snowed to-day.

December 3.—This forenoon, going north, we crossed four small lakes surrounded by scrub spruce. This afternoon at 3 p.m. we came to another lake a half mile wide by one mile long. Following up this to the north for a half mile we came to a creek surrounded with long yellow weeds, one-half mile farther we came to a big marsh. Snowed to-day.

December 4.—This morning we travelled north through swampy land and some scattered spruce ridges. At 11 a.m. we came to a tamarack swamp, about one mile square. This swamp contains about 1,500,000 feet for lumber and the trees will average 48 feet B.M. We came to a small creek at dark. Fine day.

December 6.—We followed down the creek for half a mile, through country covered with small poplar suitable for pulpwood and then came to a lake about one mile wide by one mile long. On the southwest side there is small spruce of no value. On the north side there is a small bunch of spruce covering an area about a half mile wide by half mile long. The average dimension is about 46 feet B.M. with 500,000 feet for lumber and 300,000 feet for pulp, and 1,000,000 feet of poplar for pulp. Very cold day.

December 7.—We went east this forenoon through open muskeg. At noon going southeast we came to a spruce and poplar ridge and followed along this ridge till dark. Very cold.

December 8.—Going in a southerly direction for three hours this morning, we came to a river running southeast. It was timbered well on each side with large spruce, poplar and some scattered balsam. This stream is 40 feet wide and about 8 feet deep, and the banks are 9 feet high and very steep. There does not seem to be any current. The water is bad, has a bad smell, and turns black when boiled. We followed down the stream through abundance of spruce and poplar. Spruce is the prevailing timber and is quite large. Very cold day.

December 9.—We continued down the river through spruce and scattered large poplar. A big muskeg was on our left. Very cold day.

December 10.—We continued down the river to-day about four miles. Spruce was plentiful, with a few gaps from 100 to 500 feet wide of small poplar. The big muskeg was still on our left. Very cold.

December 11.—To-day we continued down the river. At 4 p.m. we passed out of the spruce. I measured six acres and found for spruce an average of 62 feet B.M. and 9,000,000 feet for lumber, and 3,000,000 feet for pulp. The poplar averages 66 feet with 3,000,000 feet for lumber and 2,000,000 feet for pulp. The snow was 2½ feet deep on the ridges. Snowed to-day.

December 12.—We came north this morning for three miles through low land covered with willow brush. Continuing we came to a spruce ridge running north and followed the ridge till dark. The timber along this ridge is very plentiful. Cold day.

December 13.—We followed the spruce ridge all day. Very cold.

December 14.—At 3 p.m. we passed out of the spruce into an alder swamp a half mile in extent. Continuing we came to a big marsh containing a large quantity of good hay. There was a small lake at the south end. This spruce ridge is about eight miles long, and is on an average of half a mile wide. The average dimensions for spruce is 53 feet B.M. with 4,000,000 feet for lumber and 3,000,000 for pulp. The average dimensions for the poplar is 66 feet with 8,000,000 for lumber and 4,000,000 for pulp. Bright and cold.

December 15.—This morning we were in the spruce at the south end of the marsh. There is considerable spruce scattered all over this district. I have seen to-day about 1,000,000 feet for lumber, average dimensions, 55 feet B.M., and 1,500,000 feet suitable for pulp. Poplar will average 55 feet B.M. with 3,000,000 feet for lumber, and 4,000,000 for pulp. Very cold.

December 16.—We went west to-day. We were going through brush all forenoon and at noon came to a lake, on the south side of which there is considerable spruce. On the north side there is open muskeg with considerable brush. The spruce will average 52 feet and about 300,000 feet for lumber and 500,000 feet for pulp. This afternoon we went northeast and came to the marsh that we crossed yesterday morning. Very cold.

December 17.—After crossing the marsh we came to the river. The ice is very bad here. Still continuing northeast for two miles through some good spruce and poplar, we came to a big open muskeg covered with brush, after which we came to numerous small lakes with a good many small islands. These islands are wooded with small spruce of no value. Travelling farther north we reached the northeast corner of the muskeg at dark. Fine day.

December 18.—About half an hour after leaving the marsh we came into very thick brush for half a mile. Next we came to spruce and poplar, spruce being the prevailing timber. Following the ridge for another mile, the spruce became very scattered, and the poplar more plentiful. This afternoon poplar was the prevailing timber the spruce being very scattered. Bright and cold.

December 19.—We followed the ridge all day and the timber was principally all poplar with very few spruce. Snowed to-day.

December 20.—This morning we went in a northerly direction, and at 8 a.m. we came to some good large spruce. After travelling through it we found the area to be about two miles square. It contains six million feet for lumber, average dimension about sixty feet, also two million feet for pulp. Bright and cold.

December 21.—Going east this morning for half an hour, we came to open muskeg. This extends as far as I could see, and I presume that this is the open country that connects with The Pas lake. I think that this is about twenty miles east of the meridian, and about two miles south of Carrot river. Going west this afternoon we came at three p.m. to the ridge we left yesterday. We followed this ridge till dark through poplar with very few spruce. Bright and cold.

December 22.—To-day we followed the poplar ridge. There was a big open muskeg on our right. Spruce was very scarce. Very cold.

December 23.—To-day we still followed the ridge. The poplar was very large. Cloudy with west wind.

December 24.—This forenoon the ridge turned considerably to the south, following round the east end of the marsh. At 3 p.m. we passed out of the poplar, into spruce, and reached 'Bad Water' river at 4 p.m. This ridge is twelve or thirteen miles long, and is on an average three-quarters of a mile wide. The poplar will average about seventy feet in dimension, with twelve million feet for lumber and four million feet for pulp. The spruce will average about sixty feet in dimension with two million feet for lumber and one million feet for pulp. Bright and cold.

December 26.—This morning we crossed the river, and came west through low swampy land. We saw no timber to-day of any value. Mild to-day.

December 27.—We came west to-day for six hours, through low swampy land, with considerable scrub spruce. At 2 p.m. we came to scattered spruce, and remained in the scattered timber the rest of the day. Snow to-day.

December 28.—This forenoon we were still in the scattered spruce. This afternoon we remained in camp. Very stormy, with strong east wind.

December 29.—To-day I examined the scattered spruce and poplar. Snowed hard all day.

December 30.—We reached Pasquia river at 2 p.m., coming through scattered spruce and poplar. The snow was three and a-half feet deep, which made the travelling hard. Snowed all day.

December 31.—We were still in the timber to-day. The poplar was plentiful and the spruce very scattered. Snowed and was very cold.

January 1.—We moved two miles up the river to-day. The banks were wooded with brush and there was considerable hay. This afternoon we travelled north of the river. The country was the same as yesterday. Very cold day.

January 2.—We moved down to the rapids to-day. The poplar and spruce was more plentiful here. Extremely cold.

January 3, 4 and 5.—We examined the timber north and east of the rapids during the last three days. There was quite a quantity of spruce and the poplar was plentiful. We have been in scattered timber for the last ten days. Dimensions of spruce sixty feet, and six million feet for lumber, and one million feet for pulp. Dimensions of poplar fifty-five feet and ten million feet for lumber and five million feet for pulp. Last three days very cold.

January 6.—We moved six miles down the river to-day. The banks were well timbered with poplar. Very cold.

January 7.—We went north about three miles, through low swampy land. Very cold.

January 8.—We went in a southeasterly direction through some small poplar of no value, and got back to Pasquia river at dark. Very cold.

January 9.—We went down the river and reached 'Seventymile' at 5 p.m., where I expected to get some provisions, but found the place deserted. Snowed all day.

January 10.—We reached The Pas at 1 p.m. Very cold, with north wind.

January 11.—We left The Pas this morning, and reached the end of the steel at 8 p.m., thirty miles south of The Pas. Thermometer showed 48 below to-night.

January 12.—We left for Etoimami by train. Very cold.

January 13.—We reached Etoimami. Very cold.

January 14.—We remained at Etoimami waiting for the train.

January 15.—We left Etoimami and reached Winnipeg on the 18th. We left Winnipeg and reached Ottawa on January 21, 1907.

Estimated quantity of standing timber east of the second meridian and north of Pasquia river:—

Spruce suitable for lumber	32,800.000 ft.
" " pulp	16,200,000 ft.
	49,000,000 ft. B. M.
	Dimension 53 ft.
Poplar suitable for lumber	36,000,000 ft.
" " pulp	19,000,000 ft.
	55,000,000 ft. B. M.
	Dimension 62 ft.
Tamarack for lumber	3,000,000 ft. B. M.

Total estimated quantity of standing timber north of Etoimami and west of the Hudson bay extension of the Canadian Northern railway to The Pas on Saskatchewan river:—

Spruce	217,700,000	ft. B. M.
Poplar	301,800,000	"
Tamarack	24,775,000	"
Balsam	16,000,000	"
Jackpine	20,000,000	"
Birch	7,000,000	"
	587,275,000	ft. B. M.

I have the honour to be, sir,
Your obedient servant,

P. G. STEWART.

APPENDIX No. 43.

REPORT OF W. THIBAUDEAU, C.E.

EXPLORATION SURVEY OF THE COUNTRY LYING BETWEEN FORT CHURCHILL AND THE PAS

OTTAWA, May 10, 1907.

E .DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report of my exploration survey of the country lying between Fort Churchill on Hudson bay and The Pas on Saskatchewan river, undertaken in accordance with your instructions of July 26, 1906.

I left Ottawa on July 27, 1906, and arrived at Halifax on July 28, 1906. I sailed from Halifax to Hudson bay on August 1, 1906, and arrived at Fort Churchill on September 2, 1906.

I was informed by the Hudson bay people, that all the Indians had left the fort a week before, and also, being short of provisions, they could not supply me with provisions for any length of time, nor with any men or dog teams. I was therefore compelled to endure delay as to commencing any exploration from Churchill to The Pas until I could secure help, and outfit, necessary to the accomplishment of the trip. In the meantime I made a detailed exploration of Churchill and surroundings and of Churchill harbour. I left Churchill for The Pas on January 2nd, 1907, and arrived at The Pas February 16, 1907.

Fort Churchill Harbour.

This harbour can be kept open all the year by the employment of ice breakers. Last year, 1906, the harbour closed between December 5th and 10th. The conditions, January, 1907, were as follows: In the bay at Fort Churchill the ice was eleven inches thick. It extended for a third of a mile from the shore into the bay. Ice was much thinner in the bay than in the harbour. There was some floating ice about a quarter of a mile from the edge of the bay ice. This is sent in by a northerly wind; should the prevailing winds blow from any other direction, there would be no floating ice. Beyond this floating ice there was clear open water straight away into the bay and beyond. This was the general condition up to and including January 2, 1907. An ice breaker similar to either the *North* or *South*, now in use between Quebec and Lévis, would, by making two trips a week, keep the harbour open the year round.

The neap tide is twelve feet and the spring tide sixteen feet. The average current in the harbour, with the tide running out, is six knots. This current would materially assist in keeping the channel free from ice; after it was broken by the ice breaker the tide would carry it out.

The Churchill river freezes about one month before the harbour, with the result that there is no discharge of heavy ice into the harbour.

The water in the Churchill being shallow there is, consequently, only a light discharge of ice under any circumstances, and its effect on the harbour is not appreciable.

The entrance to the harbour is about 2,000 feet wide, with a minimum depth of water of ten fathoms. Vessels drawing thirty-six feet of water could enter the harbour and anchor within 200 yards of the west shore, to a point 3,500 feet south of

Fort Prince of Wales. The bay outside the harbour also affords good anchorage; there is ample depth of water.

A vessel drawing twenty-four feet of water can come within 150 yards of the east side of the harbour, from its mouth to a point 150 yards south of Battery beacon. There is also good anchorage south of the point last alluded to (150 yards south of Battery beacon) for 2,000 feet in length by 800 feet in width for vessels drawing twenty-four feet of water. Opposite Battery beacon for a distance of 2,500 feet across the harbour there is a minimum depth of twenty-four feet of water.

From the harbour entrance following the east shore, the bottom consists of sand deposited by eddies, caused by the outrunning tide. From the harbour entrance to a point 150 yards south of Battery beacon and extending into the harbour about 300 yards in width, the bottom might easily be dredged.

Churchill.

Churchill consists of two peninsulas, one on the west being about ten miles by three miles wide at the southern end, and one on the east side about five miles by two miles wide at the southern end. The western peninsula on its western side has two ridges, each from 90 to 125 feet in height; the northern one extending 3½ miles southerly from Fort Prince of Wales, and the southerly one commencing at a point 4½ miles south of Fort Prince of Wales and extending southerly a distance of 11 miles.

These ridges consist of (felspathic-quartzite) sandstone of a green grey colour, well adapted for building purposes. Fort Prince of Wales is built of this stone, and its durability may be gauged by the fact that it has not suffered, although built in 1733.

On the southerly end of the northerly ridge there is a deposit of white quartzite, similar in formation to Marble island; this stone takes a fine finish and is well adapted for ornamental building purposes; an area of about ten acres is exposed. The northerly ridge forms a level plateau, sandy in places, the southerly end being rugged. The southerly ridge is rugged from its northern end until opposite Mosquito point.

From the point of the west peninsula to the Royal Northwest Mounted Police post the terrace is sand and gravel—the balance to Mosquito point is clay and rocky till. Broken limestone is found in large quantities within half a mile southerly of the police post.

From Fort Churchill, for two and one-half miles southerly, the flat averages about one mile in width, and contains fine grazing land.

Fort Prince of Wales.

Fort Prince of Wales is situated at the west side of the entrance of the harbour at Churchill. It occupies a position about twelve feet above high water mark. It is built of sandstone quarried in the vicinity. The fort was commenced in 1733 and was completed in 1747. Joseph Robson was the engineer. The length of each side is 312 feet, three of the sides being of dressed and dimension stone both inside and out. This could be utilized for building purposes. The walls are 34 feet thick and 16 feet high, and were mounted by 40 cannon.

This fort was captured and partially destroyed by the French Admiral La Perouse in 1782.

Royal Northwest Mounted Police Post.

The Royal Northwest Mounted Police erected, in 1906, a post on the beach about 6,000 feet southerly from Fort Prince of Wales—the post consists of six nice lumber buildings.

Fort Churchill.

Fort Churchill was established in 1688 and rebuilt in 1721; it is situated on the beach on the west side of the Churchill river about five miles from its mouth, and is the headquarters of the Hudson's Bay company. It has a missionary Episcopal church; the company's stores, etc., comprise about fifteen buildings. Back of this beach, which is 100 to 200 yards in width, rise steep bare rounded hills to a height of 80 and 100 feet.

Eastern Peninsula.

Following the shore from the entrance to the harbour for 150 yards south of Battery beacon there is a rocky ridge from 30 to 45 feet in height of the same formation as the one described on the western peninsula; the stone is also well suited for building purposes. Thence, for two and one-half miles southerly, the ridge takes a bend inland. The flat in some places being three-quarters of a mile in width between the ridge and the shore line.

On the plateau formed by this ridge, between the Battery and Battery beacon, from the harbour to the bay, there are good building sites. About a mile south of Battery beacon the plateau is sandy and, extending from the river to the bay, a distance of 3,000 feet in length by 1,200 feet in width, is also good for building sites. The balance of the plateau is more or less rocky and broken.

About three miles southerly of Battery beacon, and two-thirds of a mile from the river, are three or four fresh water lakes at an elevation of 15 feet above high water. The bottoms of these lakes consist of limestone; they cover an area of about one square mile and would furnish a good water supply.

Between the lakes and the river a good site exists for large railway shops and yards. The flats are formed of clay and rocky till.

From high water mark to a point half a mile in the river the water is only two feet deep—this land is susceptible to reclamation. About two and one-quarter miles from Battery beacon, southerly on the Hudson bay shore, there is a large deposit of limestone of a cream colour. This covers an area of 1,200 to 1,500 feet and extends into the bay as far as low water mark, a distance of about half a mile. This is easy to quarry, and would make good building stone and lime for building purposes.

Although there is no merchantable timber in the vicinity of Churchill, there is abundance of fine building stone and limestone to be found everywhere, and there is also an ample supply of timber for fuel purposes for many years along both banks of the Churchill river and around Button bay.

In September, October and part of November, large shoals of white whales (I counted thirty-five in one shoal) could be seen going up river at every tide. Salmon trout and whitefish are taken in the river and harbour all the year, but are more abundant in the spring.

At Churchill potatoes, turnips and other vegetables have been successfully raised at the Hudson bay fort. For many years cattle and horses have been successfully kept and bred at the Hudson bay post. Excellent butter was also made. Splendid pasture and hay meadows are found on both sides of the river above the harbour for a known distance of thirty-five miles.

At the head of Button bay there is an area of 2,000 acres upon which good hay can be cut, which has been pronounced by Professor Macoun as affording excellent forage. Wild black and red currants and gooseberries are found in great quantities, and are the equal, if not the superior, in flavour of garden produce. Barrels of black currants can be picked around Fort Prince of Wales; cranberries exist in great abundance everywhere. Other berries which are indigenous to the climate abound.

Game and Fur-bearing Animals.

Within a few miles of Fort Churchill, in the fall and winter, large herds of barren land caribou were encountered. These herds supply fresh meat of an excellent quality for the residents of Churchill. Polar bears are occasionally shot in the vicinity. Along the western peninsula Eskimo congregate in the spring for the purpose of seal hunting. The animals frequent these shores in the spring in large numbers.

Among the fur-bearing animals are found black fox, silver fox, red and white fox, marten and wolves, both black and grey.

Swans, geese, ptarmigan and many species of duck in large numbers, and some spruce grouse are found along the shores of Churchill harbour and river.

Exploration between Churchill and North River.

Between October 24, 1906, and November 9, 1906, I made an exploration of the country between North river and Churchill river for a distance south of Button bay, of about twenty miles. On the east side of Button bay I found a strip of good timber, consisting of spruce and tamarack, six to ten inches in diameter, about half a mile wide and extending three to four miles in length on the east side, between the southern ridge of Churchill peninsula and the bay, and about three miles southerly from Fort Churchill.

At the head of Button bay (and parallel with it) there are a number of parallel ridges extending to North river. These ridges are timbered with spruce and tamarack four to ten inches in diameter. Close to North river there is good spruce timber ten to thirty inches in diameter in small scattered bunches, covering a distance of about four miles.

At the southern end of the south ridge of the western peninsula at Churchill, there is a strip of good spruce timber six to twelve inches in diameter extending about two miles by four miles; also on the east side of the same ridge about one and one-third miles south of Mosquito point, there is a strip of good timber for a distance of about four miles. The balance of the country explored was level and perpetually frozen and open, covered with thick moss and small ponds, with bluffs of scrubby timber occasionally.

Exploration to Owl River.

Between December 7, 1906, and December 17, 1906, I made an exploration of the country between Churchill and Owl river. Four miles from Churchill river in a southerly direction, I crossed a ridge, running in a northeast and southwest direction at about one and one-half miles from Hudson bay, extending opposite to Mosquito point. From the point of crossing to the bay, on the sunny side the ridge is well timbered with spruce six to twelve inches in diameter. Twenty-five miles from the starting point, I crossed another gravel ridge with scrubby timber. Two miles west of this point there is a barren hill known as White mountain, three hundred feet in height by one mile in length. At the eastern woods there are a few square miles of spruce and tamarack averaging six to eight inches in diameter. Close to White Whale lake I crossed another gravel ridge on which there is no timber. On each side of Salmon creek there are scrubs, willows and small spruce, with grassy meadows. At Broad river to the left of the place of crossing, for about four miles there is a strip of timber one-third of a mile in width, eight to fourteen inches in diameter, black spruce, stunted.

The balance of the country is open, level, plain perpetually frozen, covered with thick moss and having many ponds. For one whole day we passed through an immense herd of barren land caribou. There must have been thousands of them.

General description of the country along the route travelled from Fort Churchill to The Pas.

From station 0, Churchill harbour, the first four miles are through open country, the soil is clay and rocky till, about eight feet above high water. To the east of the proposed route, about three-quarters of a mile from high water mark, there is a sandstone ridge about forty feet high, extending towards Hudson bay for a distance of seven miles.

From station 4, the country is covered with scrub timber and tamarack for a distance of twenty-eight miles. Small shore ridges averaging six feet in height, are also found along this section. Those ridges are frozen and covered with moss.

At station 52, Deer river was crossed; at that point it is three hundred and fifty feet wide from bank to bank, and the banks are twenty-five feet high.

From station 32 to station 100, the country is a level, open plain. Some timber is seen along Deer and Churchill rivers.

At the end of September, I dug two holes, one on each side of Deer river, twelve miles from its mouth, and at seven feet deep found clay with rocky till; the material gone through was peat, containing about 50% of ice, heavily covered with moss. On this last section there are a few shallow ponds which can be easily avoided. Timber is seen along Churchill and Deer rivers.

From station 100 to station 130, Churchill river, the country is covered with scrub spruce and tamarack from four to six inches in diameter. There are also a few lakes and swamps, and some ridges from ten to fifteen feet high. This last section is about two hundred and fifty feet above Little Churchill river. From station 130 we reached Churchill river about three miles below the mouth of Little Churchill. There is no timber along this part. From that point we travelled on the east side of Little Churchill river to station 200. Along this section there is some timber from six to fourteen inches in diameter. The country is dry, more or less rolling, with a depression of ten to fifteen feet. At a distance from station 200 a ridge is seen in a southwest direction.

At station 200 we crossed again Little Churchill river, thence followed its west side to Washkaiowaka lake. That section is fairly level and dry, with some scrub timber. Washkaiowaka lake is about sixteen miles long, it has two extensions connected by narrows; clayey hills, thirty to forty feet above the lake, were seen on the northern shore of the northern part of this lake. The banks are steep and covered with very thick mossy peat, probably ten feet thick. The timber consists of black spruce and white birch from five to sixteen inches in diameter. At station 240 we crossed the same ridge seen at station 195. This ridge is 200 feet high, and runs a few degrees south of west. It is thickly timbered with spruce four to ten inches in diameter. From station 240 to station 250 on Split lake, Hudson's Bay post, the country is generally low and swampy. Travelling over three lakes, we found their shores well wooded with spruce, tamarack and birch. From Hudson's Bay Company's post to the mouth of Grass river, station 280, the country on the east side of the lake is undulating; part of the banks and islands are fairly timbered with spruce.

From the mouth of Grass river to station 294, on the east side of the river, there is no timber of commercial value. The country is more or less swampy.

From station 294 to station 310 we reached Burntwood river, which is about 450 feet wide at that point. The banks are about twenty feet high, showing granite in some places on either side. The country is hilly, with swamps and scrub timber.

From station 310 to station 355, on Grass river, the country travelled through is very much like the last described section.

From station 335 to station 364, Landing lake, the country travelled through is covered with scrub timber, with the exception of a few bunches of good timber here and there. Part of the shore of Landing lake and the islands are well timbered with spruce six to ten inches in diameter. Travelling from Landing lake to the head of Sipiwesk lake, the country was found dry and well timbered with spruce from eight to fourteen inches in diameter. About half way on this section we crossed a ridge about eighty feet high, on which we noticed Mr. Bayne's old exploration line. From station 364 to station 400 the islands of Sipiwesk lake are well timbered with spruce, some being thirty inches in diameter.

From station 400 to station 412, Nelson river, the country travelled through is hilly, dry and covered with scrub timber.

From station 412, H. B. post, on Cross lake, there was no timber of commercial value seen on the islands.

From station 422 to 436, Duck lake, the islands or portages were covered with scattered spruce trees.

From station 436 to station 460, Setting lake, the country is level and dry, covered with spruce four to six inches in diameter, and some ridges fifteen to twenty feet high, running parallel in a northeast and southwest direction. At station 438 we crossed Mr. Bayne's old exploration line.

From station 460 to station 480 we followed the west shore of lakes, and Grass river. The country is good, dry and undulating.

From station 480 to station 500 the country is dry and level, covered with scrub timber. From station 500 to 520 we struck Grass river. The country on this section is rough, and is covered with hills and ridges, some 150 feet high, running in a northeast and southwest direction. No timber of any commercial value was seen around.

From station 520 to station 558 we followed Grass river, Wekusko lake and Reed lake. The country travelled is rough and hilly.

On Reed lake the islands are well timbered with spruce six to fourteen inches in diameter.

From Reed lake to station 616 the country is level, 40 per cent being swampy. There is some spruce and tamarack timber four to eight inches in diameter.

From station 616, on the north side of Cormorant lake, there is a strip of timber, four miles wide by ten miles long. This timber is the best seen while exploring around that country.

From Cormorant lake to The Pas the country is undulating, without any timber of commercial value.

The total mileage of the route explored is 690 miles.

From the above exploration I made of the country, a good railway can be built at reasonable cost almost anywhere close by my proposed location. What is absolutely necessary is good drainage, the country having so little slope, the closer one follows the rivers the cheaper the drainage of the line will be.

The proposed route shown on the accompanying map seems to me the best location for a railway in that part of the country.

A railway from The Pas on the Saskatchewan to Churchill on Hudson bay, would be of the greatest commercial advantage for the people of the west and northwest for the following reasons:

The average saving in rail transportation, for Manitoba, Saskatchewan and Alberta, via Churchill, as against Montreal to Liverpool would be 970 miles.

The distance from Churchill to Liverpool is 2,940 miles. From Montreal via Belle Isle, 2,761 miles. From Montreal via Cape Race, 2,927 miles, from New York 3,079 miles.

The freight upon grain from the wheat belt to Hudson bay would approximate ten cents a bushel, the same as to Port Arthur—the additional fifteen cents from there to the Atlantic seaboard would be saved to the farmer, and this of itself represents a fair profit to the wheat grower. Assuming an export trade of 20,000,000 of bushels, which can easily be handled in two months of the season by the proposed railway, the saving of fifteen cents a bushel being the difference in cost of freight from Port Arthur to the Atlantic seaboard would amount to $3,000,000.

A very important feature in connection with a railway which secures quick access to the sea, is with relation to the shipping of cattle to the European markets; this great industry is at present seriously handicapped in consequence of the long journey to be endured under present conditions. It is admitted as a well recognized fact, that cattle shipped to the Atlantic coast arrive at the shipping port in poor condition, emaciated by long days of rail travel. It is also admitted that on the sea journey they gain rather than lose in flesh, if put on board in good condition. Experience proves that after three days of rail travel cattle will deteriorate; that three days is about the limit of the time during which they can travel and maintain the condition in which they are placed on board. This being so, cattle could be transported to Fort Churchill without loss in flesh, and the voyage to Liverpool would improve this condition rather than the country. Therefore this great industry alone would find in the Fort Churchill route a solution of the difficulty under which those engaged in the business of cattle shipping now labour.

Mr. F. W. Peters, assistant freight traffic manager of the Canadian Pacific at Winnipeg, states that up to the end of October over 72,000 head of cattle had been shipped to Liverpool from western Canada, and he expected a further 10,000 head to be shipped that season. The freight rate on these cattle would be about sixty cents a hundred pounds in car lots from Winnipeg to Montreal. The rate from Calgary to Fort Churchill would be about the same as to Winnipeg, and the distance about equal, so that this sixty cents a hundred pounds could be saved to the shipper if he could put the cattle on board at Hudson bay, and he would also prevent the shrinkage which would otherwise occur, by reason of the additional rail journey from Winnipeg to Montreal.

Upon the 82,000 head of cattle shipped to Montreal from the west during the past season, the saving in freight alone would be $6 a head, or, in round figures, $650,000, equal to about 20% of the selling price.

Pulp Wood.

All the timber between the head of Little Churchill river and Churchill is reserved for fuel purposes. The pulp wood belt as estimated below begins at Split lake and extends to The Pas, ten miles in width on each side of the way proposed for the route of the Hudson Bay railway. On this area, assuming one-sixth to be covered by pulp wood, the balance being river, lakes, ponds, swamps, etc., and assuming ten cords per acre of an average of six inches in diameter, there would be 5,756,660 cords. This is a very low, but safe estimate.

Water Powers.

Deer river, at its mouth, has a minimum flow of 70,000 cubic feet per minute. A dam eighteen feet high can be built at reasonable cost and would generate 1,600 horse power. Two dams of the same height could be built within ten miles of the river mouth, which is twenty-five miles from Churchill.

North river, which is three hundred and fifty feet wide during December, had a flow of not less than 250,000 cubic feet per minute. This could be dammed for fifteen feet high and would generate about 5,000 horse power.

On Churchill river, within sixty and eighty miles from Churchill, large water power could be developed and transmitted to Churchill.

Nelson river, Burntwood river and Grass river, have a number of falls which could be utilized for the development of power for use in pulp mills or other industries.

Coal and Minerals.

Notwithstanding that a most searching examination was made I failed to find any coal cropping or indications.

As to minerals, the best specimens of rock which I found at Churchill and surroundings, were assayed at the Geological Department, and contained only magnetic iron; no traces of precious metals were found. In the surroundings of Wekusko lake are many exposures of rock of Huronian formation, and this being mineral formation, should precious metals exist, the country would be an easy one in which to prospect.

Game and Fish.

From timber line on Hudson bay to The Pas are found moose and caribou in fair quantities. Rabbits are scarce throughout the country explored. We saw a few spruce grouse; ptarmigan are found plentifully, but not farther south than Grass river.

Fish.

Whitefish abound in all the lakes from Churchill to The Pas; also in some lakes are found trout, pike and sucker. Indians and travellers rely upon this source of supply for dog feed.

Swamps and Marsh.

About 35 per cent of the country travelled through is marshy and swampy; more or less hay is grown. Under marshes or swamps the soil is generally clay.

Farming Land.

I have no doubt that when the swamps and marshes are drained and moss stripped they will be susceptible to farming operations between Churchill and The Pas, and at a later period, after the Northwest is settled, this land will become valuable.

From September to January at Churchill.

September was very windy, rather cold and a few days of rain; October splendid weather, bright and clear; November some snow and rather windy; December colder and more snow. The coldest day was 38 degrees below zero. The accompanying schedule shows temperature.

I have the honour to be, sir,
Your obedient servant,

W. THIBAUDEAU, *C.E.*

1907. Month.	Day.	Place.	Aneroid at 7 p.m.	Temperature at 7 p.m.	Wind.	Thermometer. Minimum.	Thermometer. Maxim'm.	Remarks.
January	1	Fort Churchill.						
"	2	R. N. W. M. P. Post	30·67		S.	0·00		Barometer at R.N.W.M.P. post at 10 a.m. B=30·67, at 10 a.m. depth of snow 16 inches.
"	3	Mosquito Point	29·76					1 mile above Mosquito Point, tide water.
"	3	"	758 m.m.	5·00	S. E.	5·00		
"	3	"	29·76					
"	4	"	29·70					
"	4	"	757 m.m.	10·00	N. W.	5·00		
"	4	"	29·75					
"	5	Churchill River	30·09					On the middle of river amongst a bunch of islands opposite month of Deer River.
"	5	"	763 m.m.	-20·00	Calm.	-20·00		
"	5	"	30·26					
"	6	"	30·14					
"	6	"	765 m.m.	1·00	S.W.	0·00		" " some snow.
"	7	On small creek	30·35					10 feet above Deer River.
"	7	"	30·33	2·00	W.	0·00		3 miles from its mouth.
"	7	"	768					
"	8	Deer River	30·07					30 ft. above Deer River and about 30 miles from its mouth.
"	8	"	762 m.m.	2·00	S.W.	-3·00		
"	9	"	29·18					About 35 ft. above Deer River and 55 miles from its mouth.
"	9	"	29·19	2·00	Calm.	-8·00		
"	9	"	742 m.m.					
"	10	Head of Deer River.	29·06					Snow 16 to 20 inches deep, head of Deer River.
"	10	"	737 m.m.	7·00	Calm.	-8·00		
"	10	"	29·02					
"	11	Churchill River	29·44					3 miles below mouth of Little Churchill River and 124 ft. above river.
"	11	"	746 m.m.	-1·00	N. W.	-2·00		Snow 16 to 18 inches deep.
"	12	Little Churchill River	29·72					25 miles up Little Churchill River.
"	12	"	754 m.m.	-7·00	S.W.	-10·00		10 ft. above river.
"	13	"	29·82	-10·00	W.	-14·00		At Putnon Indian camp.
"	14	"	29·95	-10·00		-18 00		" "
"	15	Waskatowaka Lake	29·72					Banks 16 ft. high.
"	15	"	29.75	0·00	Calm.	-6·00		
"	15	"	751 m.m.					
"	16	Towards Split Lake	29·64					Snow 20 inches deep.
"	16	"	29·67	-10·00	S.W.	-10·00		
"	16	"	750 m.m.					
"	17	15 miles from Split Lake.	29·36					At Indian fishing camp.
"	17	Split Lake	29·36	-2·00	S.W.	-5·00		
"	17	"	741 m.m.					

1907. Month.	Day.	Place.	Aneroid at 7 p.m.	Temperature at 7 p.m.	Wind.	Thermometer. Minimum.	Thermometer. Maxim'm.	Remarks.
January....	18	Split Lake	29·46					Snow 24 to 26 inches deep, 14 feet above lake.
"	18	"	747 m.m.	-25·00	S.W.	-10·00		
"	19	"	29·60					
"	19	"	751 m.m.	-28·00	S.	-39·00		
"	19	"	29·66					" " "
"	20	"		-32·00	Calm.	-48·00		
"	21	Churchill River	29·98					1st rapid, 30 ft. above 1st rapid.
"	21	"	749 m.m.	-28·00	S.	-42·00		
"	22	Grass River	29·96					8 ft. above Grass River and 15 miles from its mouth.
"	22	"	761 m.m.	-28·00	S.W.	-38·00		
"	22	"	30·12					About 35 ft. above river.
"	23	Natawanan	29·55					
"	23	Grass River	749 m.m.	-28·00	S.	-42·00		
"	24	"	29·75					
"	24	"	753 m.m.	-4·00	Calm.	-9·00		" "
"	24	"	29.85					
"	25	"	29·47					
"	25	"	748 m.m.	-14·00	S.	-28·00		
"	25	"	29·55					
"	26	"	29·51					
"	26	"	747 m.m.	-14·00	S.	-18·00		Compon, a portage about 20 ft. above river.
"	26	"	29.52					
"	27	Nelson River	29·65	-35·00	S.W.	-38·00		Snow 3 ft. deep.
"	27	"	747 m.m.					Head of Nelson and Sipiwesk lakes.
"	27	"	29·72					8 ft. above.
"	28	"	29·69					On an island, snow 3½ ft. deep, 7 ft. above Sipiwesk Lake
"	28	"	748 m.m.	-34·00	S.W.	-42·00		
"	28	"	29·80					
"	29	Sipiwesk Lake	29·72					Portage between Sipiwesk Lake and Grass Lake.
"	29	"	29·75	-34·00	S.W.	-38·00		
"	29	"	752 m.m.					
"	30	Cross Lake	29·55					Hudson's Bay company's post, 14 ft. above lake.
"	30	"	756 m.m.	-34·00	S.W.	-38·00		
"	30	"	29·56					
"	31	"	29·46					
"	31	"	747 m.m.	-28·00	S.W.	-40·00		" " "
"	31	"	29·43					
February....	1	"	29·68					" " McLeod's place.
"	1	"	754 m.m.	-20·00	S.W.	-24·00		14 ft. above lake.
"	1	"	29.80					"

"	2	"	29·75					
"	2	"	755 m.m.	-30·00	S.W.	-42·00		
"	2	"	29·86					
"	3	"	29·47					
"	3	"	749 m.m.	-18·00	Calm.	-38·00		"
"	3	"	29·54					
"	4	West of Cross Lake	29·46					Depth of snow, 3 ft., 35 ft. above river.
"	4	"	747 m.m.	-12 00	S.W.	-7·00		
"	4	"	29·54					
"	5	Duck Lake	29·66					7 miles west of lake.
"	5	"	751	-16·00	W.N.W.	-20·00		
"	5	"	29·67					
"	6	Grass River	29·56					5 ft. above.
"	6	"	751 m.m.	-16·00	W.	-49·00		
"	6	"	29·59					
"	7	1 mile from mouth of Grass River.	29·32					Snow 2½ ft. deep.
"	7	" "	742 m.m.	-12·00	Calm.	-16·00		"
"	7	" "	29·34					"
"	8	North of Wekusko Lake.	29·20					Snow 3 ft. deep, 30 ft. above.
"	8	" "	736 m.m.	0·00	W.	-10·00		
"	8	" "	29·20					
"	9	" "	29·24					
"	9	" "	742 m.m.	0·00	Calm.	-15·00		" "
"	9	" "	29·29					
"	10	End of Railway line	29·42					Grass River, 15 ft. above.
"	10	" "	745 m.m.	-28·00	S.W.	-30·00		
"	10	" "	29·45					
"	11	Reed Lake	29 10					
"	11	" "	736 m.m.	-5·00	S.W.	-10·00		6 ft. above.
"	11	" "	29·12					
"	12	Railway line	28·73					16 miles from Cormorant lake.
"	12	"	729 m.m.	34 00	S.W.	28·00		
"	12	"	28·73					
"	13	"	29·27					On a small creek.
"	13	"	740 m.m.	5·00	S.W.	3·00		
"	13	"	29·26					
"	14	Cormcrant Lake	28·87					At the Narrows, 8 ft. above lake.
"	14	"	731 m.m.	5·00	Calm.	-5·00		" "
"	14	"	28·85	5·00	"			" "
"	15	Atikameg Lake	29·12					South end, 6 ft. above.
"	15	"	737 m.m.	30·00	Calm.	20·00		"
"	15	"	29.12					"
"	16	The Pas	28·86					At McLeod's, 12 ft above high water.
"	16	"	733 m.m.	2·00	Calm.	5·00		
"	16	"	28·87					

APPENDIX No. 44.

REPORT OF J. N. WALLACE, D.L.S.

SURVEY OF BLOCK OUTLINES IN NORTHERN SASKATCHEWAN.

CALGARY, ALBERTA, May 11, 1907.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report on the survey of the fourteenth base line, from the third to the second meridian and of part of the second meridian, undertaken in accordance with your instructions of May 1, 1906:—

I left Calgary on May 8, and after a few days spent at Edmonton, where I purchased the pack outfit and some of the horses, I left for Prince Albert and reached there on May 14. Here, owing to very rainy weather and the difficulty of getting the required number of pack horses, I was delayed for over a week.

Pack horses are hardly known as a means for transportation at Prince Albert, and it was a difficult matter, therefore, to get the right class of horses. Several of the horses I was compelled to take were too big, and caused serious delay subsequently on account of their inability to carry a pack load across swampy ground.

We left Prince Albert on May 21 and reached the northeast corner of township 52, on the third meridian, where I was to commence work, on the evening of the next day. From this date until June 1 the time was occupied in retracing that part of the fourteenth base line already run, a distance of twelve and three-quarter miles across the fractional range 28 and ranges 27 and 26.

The base line was continued as an original line easterly from the east side of range 26, and good progress was made up till September 7, when we reached Saskatchewan river at the east side of range 13, having completed ninety-one miles of line in a total of ninety-two days, excluding Sundays only.

The greater part of the district through which the line had already been run lay between the third meridian and the middle of range 23, where the road to Candle lake crosses the line. There is a great deal of first-class land in this area. Between Candle lake road and Saskatchewan river the line passes through a very mixed country. There are many good areas and many very large swamps. The soil is very sandy near the crossing of Torch river.

The Hudson's Bay company had sent a scow down Saskatchewan river in August with supplies and oats from Prince Albert and cached them on Birch island, the cache fortunately coming within a hundred yards of the line. These supplies were supposed to be sufficient to take me to Pas mountain.

Subsequent to the reaching of the river the work was seriously delayed by many causes, so much so that the average rate of progress of the last half of the work was only about half the rate of the former half.

After leaving Saskatchewan river the base line passes through a lightly timbered country for a few miles, when it meets the first of those muskegs which were to prove so disastrous to transportation during the following two months. This first muskeg begins two miles east of the township corner, between ranges 12 and 11, and extends about two miles and a-half along this range. After a vain endeavour to get round it, and finding the country north and south to be worse the farther from the line we went, we finally decided to take the horses right across the bog land, which was accomplished after much trouble.

For about six miles after this, in the neighbourhood of Petaigan river, the country is much better. Although it is thickly timbered and there are local swamps, there are some large areas of first-class land. At the end of this six miles and about four miles east of the township corner, between ranges 12 and 10, we came upon an area of muskeg, swamp and slough land, which extends continuously along the line to the crossing of Carrot river, in range 4, a total distance of twenty-nine miles.

From September 25, when we met the first of the wet lands, until November 15, when the ground became frozen hard, transportation was one continuous struggle. Open bog land or swamps, with scattered stunted tamarack and spruce, stretched for miles in all directions, and in many instances the only way to get the horses across was by constructing a causeway made of small spruce trees. For this purpose trees fifteen to twenty feet high were cut down and laid lengthwise in bundles on the surface of the bogs in a regular manner, so that the stems of each bundle were covered by the brush tops of the succeeding one. In this way we constructed an aggregate of several miles of roadway, cutting down thousands of trees for the purpose, and working day after day in water from six inches to a foot in depth.

The previous June a large amount of supplies had been sent out for me by the Hudson's Bay company at Prince Albert to their post at Pas mountain. These went down Saskatchewan river and Sipanok channel and then up Carrot river. The position of this post was shown on all maps to be at the middle of range 4.

As time went on and the supplies in camp became lower, and the general aspect of the country showed no signs of improvement, I became anxious to get in touch with Pas mountain. I was in the unfortunate position of having all the oats back at Birch island and the supply depot ahead at Pas mountain. If I persisted in going on the horses, which were daily getting weaker for want of feed, would finally play out altogether, and if I went back to where the oats were and waited for the muskegs to freeze over before continuing the line, I would have run out of supplies long before I could have got the line up to range 4, where I believed the H. B. post was. Moreover, I would have had no hay for the horses.

We had already sent back for some of the oats, but the absence of the horses on a trip back over the swamp land was so prolonged that the work was seriously handicapped by our inability to move camp, and great delay was caused thereby.

The chief trouble lay in the fact that there was no one in the party who had the least idea where Pas mountain was. The general appearance of the country was such as to inspire little hope that any one would be able to travel the necessary twenty-three miles ahead and find where the post was, and it seemed still less likely that they would be able to get any supplies back even if the post were found.

While in this dilemma it was a relief on November 12, to meet with a chance Indian hunter, the first stranger we had seen for eight weeks, and to learn from him that Pas mountain was only six miles away. Such indeed proved to be the case, the post being shown on the maps seventeen miles too far east.

Meanwhile the line had been slowly advancing and was now at the east end of range 8, about two days out of three being occupied in fixing pack trails and moving camp. Five of the horses had already died and the remainder were rapidly failing. The supplies and oats I had ordered from Fort a la Corne could not arrive until the middle or end of December, when the muskegs would be frozen over. There was no recourse, therefore, but to send the horses back to Birch island.

While the slough land was sufficiently frozen to carry horses on November 18, the tamarack bogs were not, until December 1.

On November 27, the base line was surveyed up to the middle of range 6, and a tie line of over three miles had been run to Indian reserve No. 29a. I then moved camp six miles ahead of the work and despatched the horses back to Birch island on a round trip of one hundred miles, sufficient hay for at least part of the journey having to be packed on the horses in sacks. The men returned to camp on December 11, after a severe journey, the temperature now being frequently as low as forty degrees below zero. They could bring back only enough oats to last three weeks, but the horses had been well fed since December 4, the date on which they reached the oats at Birch island, which was the important thing.

On December 20, three teams from Fort a la Corne reached Pas mountain with oats and supplies. They had a hard journey, having no regular road and having had to break trail in the deep snow for nearly the whole of the hundred miles from La Corne.

The freighters brought out your letter of December 5 in reference to the necessity of completing the work, and I considered it well to engage one of them to come back from La Corne with some more oats about the end of January, and to then help us with the transportation till we ended the work. This arrangement had a material effect in enabling me to complete the survey.

On December 21, after nearly forty miles of muskeg and slough land, we reached the crossing at Carrot river in the middle of range 4, which was the end of the wet lands.

Nothing in the way of settlement can take place along ranges 7, 6, 5 and 4 until drainage on a very large scale is carried out. Both Carrot river and Sipanok channel should afford a good basis for such a system when the progress of settlement is such as to justify large expenditures in the less favoured areas. These lands, it should be remembered, are not bogs or muskegs like the lands in ranges 8, 9, 10 and 11, but consist of flooded slough land with long reeds and grass.

With regard to the muskegs it has been stated that railway engineers, in sounding along the new line from Etoimami to The Pas, found the average depth of bog to be only four feet with a substratum of hardpan, and the greatest depth found was nine feet. The explanation of the bog would then be that the water could not drain downwards, and in these northern latitudes did not evaporate, and in the course of ages the depressions silted up. There may be some ground for the idea, that the order in course of time is bog land, tamarack swamp and then spruce swamp, the lands gradually silting up and vegetation growing at an increasing rate as the land becomes drier. I think, however, that many bogs are much deeper than nine feet.

East of the crossing of Carrot river the country is thickly timbered. At the east end of range 4, the foot of Pasquia hills was reached. The ascent up these hills continued over an exceedingly rough, broken country, composed of ravines, cutbanks, and hills, covered with timber. The snow got deeper and the work more fatiguing every day until, on January 29 we at last reached the summit at the middle of range 2, with the snow at least three feet deep and the temperature anything from thirty to forty-five degrees below zero.

The highest point reached on the line is fourteen hundred feet above Carrot river, but the hills farther south reach some two hundred feet higher.

We had been through some hard work in the muskegs between Saskatchewan river and Pas mountain, but the experience of getting the line over these hills, or rather mountains, put all else in the shade. Not only had we the deep snow and rough country, but being on the northerly slope of the mountains we were exposed to the bitter winds coming in over the vast open areas to the north. We received, moreover, little benefit from the sun, as it seldom rose, so far as the valleys are concerned, until ten o'clock and set about half-past one or two.

From the centre of range 2, the hills descend rapidly to the east, their foot being about two miles west of the second meridian.

On February 19 we closed on the second meridian. The total deficiency in one hundred and sixty-three miles was four chains and two links (265 feet) in distance, and the line struck two chains and forty links (160 feet) south of the iron post planted in 1901, which was the theoretic end of the base line.

From the summit of Pasquia hills, on the base line, an extensive view is obtained. Theoretically the horizon is some forty-five miles distant. To the northeast the country is apparently as level as the sea. By far the greater proportion appears to be composed of open slough land, bog land or lakes. For a few miles east and west of the second meridian the greater part is covered by bush of some kind, but looking to the northeast and northwest only a small fraction of the area is other than land more or less flooded.

Surveying in that area in winter will always be a severe operation on account of the deep snow and intense cold, but it would appear to be an impossibility to survey it at any other season. I may say that the satisfactory marking of the corners in such an area is a most difficult question to decide.

On February 22 we moved camp northeasterly nine miles to the north of township 53 on the second meridian from which point I was to continue on this meridian. The freighter whom I had engaged to come out from Fort a la Corne at the beginning of the month had, during the previous two weeks, been hauling hay, oats and supplies some thirty-five miles from Shoal lake to this point.

On the same date I opened up the last mile of the second meridian previously surveyed, and had the far too common experience of finding that the iron post, which should have been at the township corner, was not there. I therefore retraced the last two miles and planted a new iron post at the north of township 53.

The meridian was run north for sixteen and a half miles when we came to Saskatchewan river, where I had been instructed to end. On the southerly bank I planted a temporary iron post marked 'II Mer.' It is twenty-nine chains north of the southeast corner of section 25, township 56. An approximate connection was made with the traverse of the river made by Mr. Klotz, D.T.S., in 1884, and on the evening of March 12, a pretty well tired out survey party made their way back to camp, through the deep snow, for the last time.

Next day we commenced the homeward journey of two hundred miles to Prince Albert travelling back along the meridian to Carrot river and up this river and Sipanok channel and so to Shoal lake and then to Red Earth (Pas mountain).

From Red Earth, we had a journey across country of nearly one hundred miles to Fort a la Corne, which place we reached on March 22, and finally reached Prince Albert on March 25, after an absence of ten months. The party were paid off the same day, and I reached Calgary myself on March 30.

In all, one hundred and eighty-three miles were surveyed of which a total of fourteen and a half were retracement.

The lands along the base line and meridian are described in detail in attached separate report.

As regards the summer climate I should consider it very good for agriculture. There is abundance of rain. The only summer frost occurred on the nights of August 22, 25 and 30 when ice as thin as paper was formed. The minimum temperature was 28°. The first snow to remain, fell on November 2. The first frost of any consequence occurred about November 15. On November 29 the temperature dropped suddenly to 5° below zero and on December 7 to 41° below. During December, January and the first of February the cold was steady and intense, not abating, even for a day. It was considered an exceptionally severe winter all over the Northwest, but it is always severe near Cumberland House and The Pas.

The hottest day of the season was August 13, with a temperature of 92° in the shade.

As the matter of transportation is becoming every year a greater strain on the resources of the survey, a few general remarks on the comparative value of horses and dogs in winter transportation may not be out of place.

A team of dogs consists of four as a rule, harnessed one in front of the other, but in the country near The Pas the team consists of five, as the dogs of that country are small. A dog's ration is two or three fish given to him once a day, in the evening. Each fish weighs about two and a half pounds on the average, so that each dog consumes about seven pounds of fish a day. For a team of five dogs this amounts to thirty-five pounds. The team will draw as much as four hundred pounds.

On the other hand ponies can be kept on ten pounds of oats and twenty-five pounds of hay. Last winter I fed the ponies only seven pounds of oats daily and about twenty-five pounds of hay per head, and they came through in good condition. The only protection they had was a double pack blanket sewn under a heavy canvas pack cover. They never had a tent, rather because I hadn't one, than because I did not think it worth carrying. Each pony carried up to five hundred and fifty pounds. We used flat sleighs, fourteen feet long and twenty-four inches wide, although a width of only twenty or twenty-two inches is better.

We have then the general conclusion that a dog team will haul four hundred pounds with a daily consumption of thirty-five pounds of feed, and that a pony will haul five hundred and fifty pounds when supplied with practically the same weight of feed. Unless, therefore, the greater distance-covering power of the dog team can be utilized, its advantage over a pony is not apparent.

When working in a bush country, a survey camp can seldom be moved more than six miles at a time, and not more than twice a week. For such short heavy hauls with bulky freight, such as tents, rolls of blankets, cook outfit, etc., unsuited to a light dog sleigh, the pony is certainly ahead of the dog team; while for bringing in compact heavy freight, such as supplies or oats to camp from a far-off base, a dog team is more satisfactory. Moreover, the dog's power to cover a much greater distance than a pony, enables a surveyor to keep the dogs at the base of supplies and have them only visit his camp periodically with supplies. He is therefore relieved of the necessity of having to haul fish for the dogs' use while in camp between trips.

The disadvantage of the pony, as compared with the dog team, is his slower pace and the bulk of his hay. Of course, there are often other considerations which in a practical instance would be the determining factor in deciding which of the two means to use. In some regions fish are plentiful and hay impossible to obtain. In others the reverse is the case. Fish are not so easily obtained as is generally supposed.

If a surveyor is notified in time that he is to work during the winter in a certain district, he can frequently arrange to have hay put up for him during the previous summer not very far from his district. This will, of course, generally be slough hay, and many ponies have to be first trained to east this. The greatest distance I had to haul hay last winter to camp was fifty miles.

An experienced man can pack four hundred pounds of hay, or even more, on a flat sleigh. In loading hay the side ropes are laid out on the ground and a wagon cover laid down on top of the sleigh. The hay is carefully loaded on, keeping it in long rolls as it is drawn from the stack. The canvas is then turned up over the sides and the whole is roped down until almost as hard as baled hay. A pony can thus haul enough hay to last himself at least sixteen days. This was the actual rate at which hay was supplied to the ponies last winter. I may say a very great deal depends on the man who has charge of the ponies. It is almost impossible to get some men to serve exact rations of hay and oats.

There cannot be very much difference in the daily cost of feeding dogs or ponies. The fish necessary for a dog team will cost about fifty cents a day delivered within a few miles of where they are caught. In the regions where base lines are now being run oats will cost about one dollar and a-half a bushel delivered, and hay should not run over a cent a pound at the outside if put up in the district. This would make the total cost of the pony's feed about seventy-five cents a day. As he carries nearly half as much again as the dog team, the cost works out practically the same. For exploration work, or for bringing supplies or oats periodically to camp, a dog team is ahead of a pony. In general, a long, quick journey with a compact load, especially if the snow is deep and the country open, is the ideal condition for using a dog team. For slow, heavy freighting in the bush, such as occurs in working along a base line, a pony will generally be best, even if oats are expensive and hay bulky. I believe the combination of the two methods indicated above will often be found to work out satisfactorily.

I wish to record the manner in which Mr. F. W. Rice, my assistant, stood the many trying days of the winter. He had perhaps the hardest task in the outfit in managing the transit work, and that we were able to complete the survey was due in a large measure to his power of endurance.

I have the honour to be, sir,
Your obedient servant,

J. N. WALLACE, *D.L.S.*

APPENDIX No. 45.

REPORT OF ARTHUR O. WHEELER, D.L.S.

PHOTO-TOPOGRAPHICAL SURVEY OF THE ROCKY MOUNTAINS.

CALGARY, Alberta, November 26, 1906.

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—The party left Calgary for the field of operations on June 10. With one assistant, the writer stopped at Banff to take some views from Sulphur mountain, for the purpose of ascertaining the speed of the plates to be used during the survey; and then returned to Calgary to develop these test plates. The remainder of the party gathered at Laggan, to which point the pack horses and survey outfit had been sent two days before.

Ptarmigan Lake Country.

A short distance northeast from Laggan, on the Canadian Pacific railway, lie some beautiful alpine valleys dotted with small lakes and enclosed by strikingly bold snow-clad peaks. This region, situated chiefly in townships 29 and 30, range 15, west of the fifth meridian, has begun to attract the attention of the tourist; so much so, that in 1905 the railway company put in a well-graded pony trail to accommodate visitors to the mountains staying at Lake Louise chalet. As previous surveys had not embraced this particular locality, a camp was taken near the summit of the watershed between Bow and Red Deer rivers, and later a second camp was established on the headwaters of Red Deer river. In all, ten peaks were climbed in the vicinity and twenty camera stations occupied furnishing full information for mapping. Work here was closed on July 4.

At this high altitude, the spring had barely set in and snow was still lying plentifully on the passes and the lakes were clad with ice. It snowed every other day, thereby much retarding the work. The lake near the summit of the pass from the Bow valley, forming one of the extreme sources of Red Deer river, is locally called Ptarmigan lake. It is well named, for round its shores, in all the adjacent valleys and on the alpine slopes above the timber-line flocks of this most interesting species of the grouse family (*lagopus leucurus*) abound. They are a very valuable feature of the bird life of the Rocky Mountains park, and should be rigourously protected; more particularly the robbing of their nests should be punished. Through the main valleys connecting with the headwaters of Red Deer river are deeply worn ruts made years ago by large herds of buffalo passing to and from Bow, Red Deer and Saskatchewan rivers, showing that these sheltered valleys were their favourite wintering grounds.

Two exceptionally fine peaks, Mts. Douglas and Drummond, named after noted naturalists, rear their massive forms on opposite sides of Red Deer river. In their vicinity are a number of most charmingly picturesque lakes. The larger valleys of the district present rolling park lands and open pine woods, and furnish a paradise for botanists and those desiring to camp amidst beautiful mountain scenery. As a tourist resort, the locality may be recorded as one of the most attractive of the entire Rocky Mountains park.

Alpine Club of Canada.

In March of the current year the Alpine Club of Canada was organized at Winnipeg. It was based upon the principle that it should be a national institution and that its first object should be to interest the people of Canada in their own mountain regions. To this end, it was decided to hold a first annual camp at the summit of Yoho pass, in the Yoho National park, from the 9th to the 16th of July, with accommodation for one hundred persons.

At this early stage of the club such an undertaking would have been impossible but for assistance rendered from three special sources, viz.: From the Dominion Government by contributing the services of the writer's survey party, from the Government of Alberta and private persons by money contributions, and from a number of the mountain outfitters, who contributed men, horses and outfits, free of charge, to make this first camp a success. And a success it was. One hundred and twelve persons were present, among whom were representatives from England, the United States and South Africa and from numerous points throughout the length and breadth of Canada. No spot in the entire system of Canada's mountain splendours could have been found where more diverse and representative features are presented and the immediate result of that camp has been to bring the club's membership, within its first year, up to one hundred and sixty-five, with an enthusiastic demand for a repetition of the camp for next year, when the attendance promises to be much larger.

The survey party was engaged with this camp until July 18.

Amiskwi Valley and Otto Creek.

To the west of the President's range lies the valley of Amiskwi river leading over a watershed, shown on a previous explorer's map as 'Baker pass,' to Blaeberry river, and thus to the headwaters of the Saskatchewan, via the old Howse pass. About halfway between Kicking Horse river, into which the Amiskwi flows, and Baker pass, a tributary enters the latter stream from the northwest. By following the tributary to its source a pass is arrived at which likewise leads to Blaeberry river. They have been named, respectfully, Otto creek and Otto pass.

This depression cuts into the eastern edge of Van Horne range on a course parallel to its direction, and from July 20 until August 2, the party was engaged in gathering such topographical information as could be reached from it. Seven peaks were climbed and thirteen camera stations occupied. Two additional climbs were made in the Amiskwi valley and four camera stations occupied to supplement information obtained the previous season, but found inadequate owing to smoke from bush fires. During the dates above mentioned frequent showers occurred and some hail and snow fell, but not sufficient to interfere materially with the work. Both the Amiskwi and Otto creek valleys are densely timbered. Much of the timber, chiefly spruce, is of merchantable value and lies within the timber limits of the Palliser Mills company.

Valley of Otterhead River.

Van Horne range was next entered by way of Otterhead river. An old lumber road extends for about two miles up the stream, but from that point on a pony trail had to be cut out clear to the head of the valley, a distance of about nine miles through thick timber. About halfway the stream forks, a tributary coming in from the northeast. The westerly or main stream was followed to the pass at the head of the valley, which leads across a glacier to a valley discharging its waters into Blueberry river. On the west side of the pass stands a flat rock mass, which, seen from the direction of the valley, has a very striking appearance, rising into the air like a huge spike. Directly to the south of it an easy pass gives access to a large valley with many tributaries, all sending glacier fed torrents to feed Glenogle creek, which joins Kicking Horse river near Glenogle station on the railway.

The work was carried for some distance down on the Blaeberry side of the pass, and also into the Glenogle creek valley as far as it was possible to extend it. On the 20th the ascent of Mt. Deville was commenced, but a heavy fall of snow forced a return, and as this early snowfall entirely changed the character of the landscape for several days, the party was compelled to move on.

Altogether, between the 5th and 21st August, nine peaks were ascended and sixteen camera stations occupied. Throughout this period of the work smoke from bush fires was a highly detrimental factor. The valley is in parts heavily timbered with good merchantable spruce, but is understood to be already under license.

Moose Creek Valley.

Work was now transferred to the south side of Kicking Horse river, and a move made up the Beaverfoot as far as Ice river. A peak was climbed close to the Shining Beauty mine on the north side of the latter and two camera stations occupied. The Shining Beauty has been working steadily all summer. It employs about thirty men. The ore—silver, copper and zinc, with a trace of gold—yields about $49 to the ton. About thirty-five tons of supplies have been packed in for winter consumption, and it is understood that the company owning it are about to put in an up-to-date concentrator.

Dense smoke on August 26 rendered photographing impossible, and compelled the party to move on up the Beaverfoot valley to Moose creek.

Moose creek, as it is locally called, is in fact the actual source of Beaverfoot river. Utilizing the smoky weather for travelling, the party went direct to the head of the valley by means of a trail leading to a mine now being operated by the Shining Beauty company. Rain on the 27th and 28th cleared the atmosphere, and on the 29th and 30th climbs were made of Mt. Sharp and Helmet Mt., both peaks being situated at the head of Moose creek.

On September 3, a climb was made of Zinc mountain. On the east slopes of this mass the mine above referred to is situated. A tunnel has been pushed in more than 200 feet and some excellent ore taken out—zinc, silver and copper—but no work is now being done except the yearly development necessary to hold it. On the 4th stations were occupied along the north edge of the Washmawapta glacier, giving data to map the glacier and also overlooking the head of the Ottertail valley and Ochre creek, tributary to Vermilion river. From the 5th to the 9th it rained incessantly, and no work could be done.

Two other stations were occupied in connection with this tract of country. In all, nine peaks were climbed and eight camera stations occupied.

Moose creek is remarkable for the large flocks of wild goat seen on the steep slopes of Mts. Sharp and Helmet and around the moraines of the Washmawapta glacier.

Beaverfoot Range.

On September 13, the party proceeded up the Beaverfoot valley and crossing the watershed camped on the headwaters of Kootenay river. From now on, until October 2, the energies of the party were concentrated upon obtaining data to map the Beaverfoot valley and inclosing ranges, and to obtain as much data as could be got from summits along the Beaverfoot range.

The Beaverfoot valley is six to eight miles wide and densely timbered. On the east side a good pony trail leads up Beaverfoot and down Kootenay river to Windermere and Steele. On the west a wagon road connects Palliser station on the Canadian

Pacific Railway with the Palliser Mill Company's camp, about ten miles up the river. Down the centre of the valley, on the Kootenay side of the watershed, open meadows dotted with ponds extend for about eight miles. These facilities were used to move the camp, but in the case of every ascent made on either side, it was necessary to cut out from three to four miles of trail through dense woods to attain a point from which a summit could be reached. From the crests of the Beaverfoot range splendid views were obtained of the broad Columbia valley, glistening in every direction as the sun shone on winding river and innumerable ponds and channels covering the valley bottom in a network; beyond, lay the serried, snow-clad array of the Spillimacheen mountains. To cover this section, eight peaks were ascended and thirteen camera stations occupied.

All the good timber tributary to Beaverfoot river is under license to the Palliser Mill company. A tract has been burned along the northeast slopes of the Beaverfoot range, but south of the meadows previously referred to, large tracts are found on both sides of the Kootenay valley that are still intact and would be of great merchantable value if there were a waterway of sufficient volume to carry the logs. The timber is chiefly spruce and Douglas fir with a considerable quantity of pine, particularly on the northeast side of the valley.

Game is very abundant, moose and smaller deer being found in the woods surrounding the meadows referred to, where there are a number of salt-licks, and goats on all the peaks above timber-line. The crests and long ridges of the Beaverfoot range seem to be a favourite spot for goats. They were seen here in every direction in flocks, sunning themselves, and were so tame and would come so close that they could be hit by tossing a pebble. Grouse of two kinds are very plentiful in the woods and ptarmigan on the slopes above timber. Indications of a few beaver were seen around the meadows near the watershed and in Ice river valley, but they are few, and it will only be by careful protection that they will be saved from extinction.

Kicking Horse Canyon.

Between the 6th and 15th October four ascents were made along the lower canyon of Kicking Horse river and eight camera stations occupied. The weather during this period was broken and the winter snows gradually collected on the summits, so the traverse of the railway line was picked up at Glenogle, where it had been discontinued the previous year, and on days when climbing was out of the question it was carried forward westerly to Golden.

Traverse of the Railway.

From the 16th to the end of October a careful traverse of the railway was carried from Golden to Donald and ties made with established survey corners, the main camp having been moved to Moberly for this purpose. Camp was broken up on November 1, and the party returned to Calgary.

Statistics of the Season's Survey

The season was an exceptionally fine one, the field work extending over 154 days. Of these, 48 days were spent in preparing for the survey, moving camp, rest on Sundays and storing outfit; 16 days were lost through bad weather, rain or snow; 6 were lost through smoke from bush fires; and the remainder, 84 days, were spent upon the actual work of the survey.

Altogether 47 ascents were made and 89 camera stations occupied, from which 471 plates were exposed. At each camera station a round of photographs were taken and azimuths to obtain orient points for the views. To reach the peaks with instruments, 24 miles of trail had to be cut through thick timber. Along the railway, 25 miles of traverse were made between Glenogle and Donald, each course being chained twice to ensure accuracy.

Three kinds of plates were used, viz:—Seed's non-halation L. Ortho, Lumière, non-halation A orthochromatic and Cramer's slow isochromatic. The Seed plate has a unit of exposure of five seconds with the orange screen used, the Lumière ten seconds and the Cramer fifteen seconds. The Lumière plates give the best results.

Progress of the Work.

The topographical survey of the main range of the Rocky mountains has now been completed westerly as far as Columbia river at Golden. It extends, generally speaking, twenty miles on either side of the railway, being bounded on the north by parallel 51° 31′ N. latitude, by the Pipestone and Bow passes and by Blaeberry river; and on the south by parallel 51° N. latitude, by the summit of the range and by the south boundary of the railway belt. In order, however, to connect with the survey of the Selkirk range, from Beavermouth to Revelstoke it is still necessary to make a survey of the Spillimacheen mountains and the Dog-Tooth range, lying between Columbia and Beaver rivers south of the railway. There also remains a portion north of the railway between Blaeberry and Columbia rivers. The Spillimacheen mountains are of considerable importance, owing to mining interests held in their midst, and there is a growing demand for maps of that region. It is proposed to fill in the gaps outlined by another season's work.

The map work of the mountain territory surveyed is now being pushed forward as rapidly as possible. The tremendous influx of tourists, hunters and those engaged in scientific research has caused the railway company to add yearly to its mountain hotels, until what were formerly small chalets are now magnificent edifices offering the most refined comforts of civilization. This influx, to which a very considerable zest has been added by the formation of the Alpine Club of Canada, means an ever increasing revenue to Alberta and British Columbia through catering to the wants of these people. There is a constant demand for accurate maps. While it is impossible to complete a map of the whole until the field work is completed, this office has been endeavouring to put out advance sheets of the parts most required by tourists, and will, during the coming winter, get ready an advance topographical sheet of Yoho park with that object in view.

I have the honour to be, sir,
Your obedient servant,

ARTHUR O. WHEELER, D.L.S.
Topographer of the Department of the Interior.

DESCRIPTIONS OF TOWNSHIPS

DESCRIPTIONS

OF

SURVEYED TOWNSHIPS

Submitted by Dominion Land Surveyors during the Season of

1906-1907

APPENDIX No. 46.

LIST OF TOWNSHIPS DESCRIBED.

East of Principal Meridian.

Township.	Range.
15	7
14, 15	8
7, 9, 10, 14	9
1, 2, 6, 7, 8, 9, 14, 15	10
1, 2, 6, 7, 8, 9	11
2, 3, 6, 7, 12, 13, 14	12
3, 4, 5, 7	13
3, 4, 5	14

West of Principal Meridian.

Township.	Range.
17, 19	1
18	2
19, 20	3
16, 19, 20, 23, 24	4
18, 19, 20	5
19, 20, 23, 24	6
22, 23, 24	7
15, 16, 17	10
15, 16, 17, 18	11
34, 35	22
28, 32	23
6, 24, 35	25
6, 35	26
6, 7	27
5, 6, 7, 8	28
5, 6, 7, 8, 9	29

West of Second Meridian.

Township.	Range.
52, 53, 54, 55, 56	1
52	2
44, 52	3
52	4
52	5
52	6
52	7
52	8
7, 52	9
52	10
52	11
52	12
52	13
52	14
52	15
52	16
52	17
52	18
14, 52	19
52	20
52	21
50, 51, 52	22
50, 51, 52	23
50, 51, 52	24
5, 11, 12, 50, 51, 52	25
11, 12, 51, 52	26
7, 8, 52	27
7, 8, 9, 10, 11, 52	28
7, 8, 9, 10, 11	29
6, 7, 8, 9, 10, 11, 14	30

LIST of Townships Described—*Continued.*

West of Third Meridian. Township.	Range.
51	1
50, 51	2
21, 22, 23, 50	3
10, 21, 22	4
21, 22	5
21	6
21	7
21, 22	8
9, 10, 11, 12	11
9, 10	12
29, 30, 31	19
21, 22	27
21, 22	28
2	29

West of Fourth Meridian. Township.	Range.
59, 60	7
59, 60	8
59	9
59, 60	10
3	12
1, 3, 6, 7, 65, 66, 67, 68	13
6, 7, 8, 35, 68	14
6, 7, 8, 35, 68	15
6, 7, 8, 35, 68	16
6, 7, 64, 68	17
28, 64, 68	18
64, 68	19
51, 59, 64, 68	20
58, 64, 68	21
11, 64, 65, 68	22
64, 68	23
64, 68	24
61, 64	25
61, 64	26
58, 59, 61, 64	27
13	29
1, 3, 4	30

West of Fifth Meridian. Township.	Range.
1, 2, 15	1
5, 13, 14, 15	2
5, 6, 7, 8, 9, 11, 12, 17, 18, 19, 20. 50, 60	3
10, 11, 12, 22, 56, 57, 58, 59, 60	4
50, 57, 58, 59, 60	5
8, 50, 51, 55, 56, 57, 58, 59, 60	6
56, 57, 58, 59	7
58, 59, 60	8
26, 27	11
26, 27, 28	12
76, 77	14
75, 76	15
73, 74, 75, 76	16
74, 75	17
64	19
64	20
64, 80, 84	21
80, 84	22
80, 84	23
80, 84	24
84	25
84	26

West of Sixth Meridian. Township.	Range.
18, 20	24

DESCRIPTIONS OF TOWNSHIPS.

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 7.

15.—There are a few settlers immediately west of the portion of this township which I surveyed, but only a few, for the western portion of the township is nearly all muskeg. *C F. Aylsworth, D.L.S., 1906.*

Range 8.

14.—West of Brokenhead river this township is very densely settled; east of the river it is only sparsely settled. On the west side of the river the roads have all been graded and ditched; on the east side of the river none of the roads are graded and it is only partially ditched.—*C. F. Aylsworth, D.L.S., 1906.*

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 8—Continued.

15.—There are no settlers living east of the lands I have surveyed in this township. The land in this township, so far as I could observe, is practically all muskeg. *C. F Aylsworth, D.L.S., 1906.*

Range 9.

7. This township is easily reached by the Dawson road from Ste. Anne, and the Sprague trail—which leaves the Dawson road in section 11, township 8, range 9, and runs in a southerly and easterly direction passing through the northeast quarter of section 36, in township 7, range 9. Both the Dawson road and the Sprague trail are in good condition. No entrance, except as above, could be made into this township with horses in summer time. The lower portions of this township are covered with a thick growth of peaty moss and the greater part of the higher portions is sandy and stony, though some parts have a thin top dressing of black loam. In general the soil of this township is not good for agriculture, though a small portion of arable land consisting of black loam on a subsoil of sandy loam or sand is found in portions of sections 21, 22, 27, 28, 32 and 33. The whole of the surface of this township is covered with bush or heavy scrub, with occasional marshes scattered throughout the township. The southeastern quarter of the township is swampy and in some places there are floating bogs or muskegs which render this portion of the township nearly impassable. The northern and northwestern portions consist of sandy and stony ridges. The timber consists of tamarack, spruce, jackpine and poplar, very little of which could be used for lumber as it is too small or too crooked. A few railroad ties and fence posts could be cut in the eastern portions of the township. Practically the whole of the central and western parts of the township have been burnt over and the timber is nearly all fire-killed, but is mostly standing yet. A small amount of coarse hay could be cut in sections 29, 30 and 31. Other small hay meadows are scattered throughout the township, but these would be suitable only for pasturage. Water is plentiful and permanent in the eastern and southern portions of the township but the northwestern portion is dry, and in a dry summer, water could be got only by digging, except for one marsh located at the northeast corner of section 30. All the water is fresh. A shallow lake, about one hundred and forty acres in area, is located at the corner of sections 1, 2, 11 and 12. Brokenhead river takes its rise in sections 35 and 36. A small branch comes out of each of the above mentioned sections and they unite in section 2, township 8, range 9. These branches at the time of survey were merely tiny streams about one foot wide and one foot deep with a slow current. No falls or rapids occur and no water-power could be developed. Practically the whole of sections 1, 2, 3, 10, 11, 12, 13, 14, 15 and 23 are more or less flooded all the time. The climate is very mild and no summer frosts occurred. Fuel consisting of tamarack, spruce and jackpine is plentiful in all parts of the township. No coal or lignite veins were seen. No stone in place was seen though surface stones and boulders were plentiful in the northwestern portion of the township. No minerals of economic value were encountered. Traces of moose and bear are plentiful, but other game is scarce.—*H. S. Holcroft, D.L.S., 1906.*

9.—This township is reached from Ste. Anne on the Canadian Northern railway, by using the Dawson road as far as section 17, in township 8, range 9. At the house of a settler named Edward Harrison, in this section, I left the Dawson road and followed Chartier's logging trail, which has a general northeasterly direction to Chartier's sawmill, in section 12, township 9, range 9, east of the principal meridian. A good trail leaves this trail in section 1 and runs north and then west to Nolin's old sawmill in section 14. This township is composed of three general classes

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 9—Continued.

of country: (1) High level ground covered with poplar, willow and windfall. This class occupies southwest half section 25, northeast half section 26, southwest half section 35, section 34, northeast quarter section 33, section 1, northeast half section 2, section 12, section 11, southwest quarter section 13, west half section 15, sections 16, 20, 21, southwest half section 29, east quarter section 30 and east half section 31. In places this class also carries a little jackpine. The soil is light and sandy, with numerous stones and boulders. (2) Swamp and muskeg, heavily covered with spruce, tamarack, and cedar, from 2 to 10 inches in diameter, and occupying southwest three-quarters section 36, northeast third section 35, northeast third section 25, section 24, north two-thirds section 13, north two-thirds section 14, section 23, southwest half section 26, northeast half section 27, east half section 15, section 10, section 3, southwest half section 2 and southeast quarter section 4. The soil is a black loam or vegetable mould. (3) Swamp and muskeg, partly open and partly covered with dead spruce and tamarack and willow scrub. This class occupies northeast quarter section 36, southwest half section 33, east half section 32, northeast three-quarters section 28, southwest half section 27, northeast half section 22, north half section 4, south half section 9, sections 5, 6, 7, 8 and 18, west half section 17, section 19, west half section 30, west quarter section 31. This is wet and marshy and covered to a depth of several feet with moss. The location of the timber is described above. The spruce and tamarack is all too small for lumbering purposes, the best having been taken out by the settlers around Ste. Anne. There is a poplar and jackpine ridge in section 12, which, however, has also been cut over. No hay is to be found. Water is all fresh and the supply abundant and permanent. A small stream enters the township on the south boundary of section 2 and crosses the east boundary of section 3 at eighteen chains north of the south boundary. It then empties into the large marsh occupying the southwest corner of the township, and is not noticeable on any other of the lines in the township. The area described above under (3) would probably be flooded to a depth of two feet in a wet season. At the time of the survey (May and June), however, water occurred only to a depth of about six inches. No water-power is available. The climate is moderate, with light frosts in the early part of June. Firewood, consisting of dead spruce, tamarack and poplar, is everywhere plentiful. The supply is sufficient for the wants of settlers for many years. No stone quarries or minerals are to be found. The game is moose, red deer, bear, grouse, porcupine, weasels and wild turkeys.—*J. L. R. Parsons, D.L.S., 1906.*

10.—This township was reached from section 34, township 9, range 9, by my own trail northerly along the east boundaries of section 4 to the quarter section corner on the east boundary of section 9. From this point my camp had to be packed by men to section 27, as the surface was of too soft and swampy a nature to allow the use of horses and wagons. The soil of the township may be divided into three general classes: (1) High ground, wooded with poplar, willow and a few jackpine. This class is sandy, with many boulders, but in a few places white clay was encountered. It is, however, of too light a quality to be suited for agricultural purposes. It comprises the northeast quarter section 32, 33, southwest three-quarters 34, 27, east half 28, northeast quarter 22, 23, south half 24, 14, 13, west half 3, 4, 6 and 7. (2) Swamp or muskeg, wooded with spruce and tamarack, or fire-killed spruce and tamarack. The soil in this class is invariably a deep black loam, but is not suited for agricultural purposes on account of the presence of a great deal of water. It can doubtless, however, be drained and should then be valuable. It comprises section 36, northeast quarter section 35, southwest three-quarters sections 32, 31, 29, west half 28, east half 26, northeast half 24, south half 22, 21, northeast quarter 20, east half 19, 11, 12, 2, northeast and southwest quarter sections 1, 10, northwest three-quarters 9, 8, northeast quarter 5 and northeast quarter 3. (3) Marsh or muskeg, containing a great deal of water, with scattered

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 9—Continued.

dead tamarack and scrub, and being composed of moss to a depth of several feet. It is unfit for agriculture. This class comprises southeast quarter 35, 25, north half 30, middle third of 20, east half 18, 17, 16, west half 15 and middle third 1.

The surface is level and covered with timber as described above. All the best timber has been cut in the township, but the young tamarack, spruce, poplar and jack-pine, should be large enough to cut in a few years. There is no hay. Fresh water is abundant and the supply permanent. A branch of Brokenhead river crosses section 36. It is two chains wide and four feet deep and flows with a current of about one and one half miles per hour. Its banks are well defined and flooding is therefore improbable. No water-powers occur. The climate is moderate with abundant rainfall in June (during the time of the survey), with no frosts at this time. Good fuel is everywhere obtainable among the fire-killed timber and windfall. There were no stone quarries or minerals found. Moose, red deer, bear and partridge are all quite numerous.—*J. L. R. Parsons, D.L.S., 1906.*

14.—The southeast corner of the township is crossed by Lac du Bonnet branch of the Canadian Pacific railway, a wood siding, Milner, being in section 12. The township is mostly swamp, muskeg or sand ridge, but there is a strip of good land along the west boundary and perhaps some more about the middle of the northeast quarter of the township. The latter, however, is covered with heavy woods, both green timber and brulé. A number of Galicians have settled in the western tier of sections but on account of their buildings being scattered in the scrub it is impossible for me to show the position of them in my notes. The timber is mostly spruce and tamarack, small in the wettest parts of the swamps and larger in the drier portions. All the large timber has been cut. Much cordwood is cut here every winter. I believe that this township is in a wood or timber limit belonging to J. D. McArthur. I saw no hay meadows, except those claimed by the settlers along the west boundary. The water is fresh. There is a small lake in section 24 and there are several small creeks which lose themselves in the swamps. I saw no coal, minerals or stone of any economic value. Moose, deer, timber wolves, chickens and partridges are plentiful.—*Geo. H. Watt, D.L.S., 1906.*

Range 10.

1.—The greater part of the soil in this township is useless, being only fourth class, made up, principally of floating muskegs and spruce and tamarack swamps. There are, however, about eight or ten good quarter sections in the southwest corner which, when cleared, will make good farming land. The greater part of the land is covered with bush, consisting principally of spruce and tamarack averaging from three inches to seven inches in diameter, and a considerable amount of spruce and tamarack and willow scrub, especially in the swamps and muskegs. Hay can be had in the southern part of the township, enough to supply the settlers. There are no streams of any kind to be found, but good water can be had in the swamps and by digging a few feet in almost any place. The climate is the general Manitoba climate, without any indications of summer frosts. Fuel can be had in unlimited quantities all through the district, consisting principally of spruce and tamarack. There are no coal or lignite veins, minerals or stone quarries to be found. Moose is about the only kind of game to be found. The Emerson-Vassar branch of the Canadian Northern railway runs through the northeast corner of the township. It is impossible to reach this, however, from the central or southern part of the township on account of swamps and muskegs. There is a trail leading from the settlements in the township to the west, but even this is difficult to travel on except in the winter.—*John Molloy, D.L.S., 1906.*

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 10—Continued.

2.—The greater portion of the soil in the township is a black or sandy loam from five inches to eighteen inches deep with a sandy clay subsoil and would be fit for farming purposes only on account of the land being so wet and almost impossible to get into. All the land is covered with bush consisting mostly of spruce, tamarack from five inches to ten inches diameter, and poplar, willow and jackpine scrub and brulé equally distributed throughout the township. The southwest quarter of the township is mostly dry tamarack about five inches diameter with low willow scrub and swamp. There are no hay meadows, but if the land was cleared and drained hay could be had in large quantities all through the township. All the water is free from alkali and of first-class quality. There are no streams to be found. The climate is the general Manitoba climate with no summer frosts. Fuel can be had in abundance all through this district, consisting of spruce, tamarack, poplar, cedar and jackpine. There are no coal or lignite veins, minerals or stone quarries. Game consisting of moose, deer and bear are very plentiful all through this section of country. A winter trail leading to Woodridge, a village on the Canadian Northern railway about two miles north, passes through the western portion of the township and continues southeast to the settlement of Pine Valley in township 1, range 12. There is a store, postoffice and school in both these places. The Emerson-Vassar branch of the Canadian Northern railway passes through the southwest corner of the township. *John Molloy, D.L.S., 1906.*

6.—This township is situated about sixteen miles northerly from Bedford station, on the main line of the Canadian Northern railway, and is most easily reached by the Mennonite trail from Bedford. This trail passes over a range of low hills, and it is a very good wagon trail. The soil in the higher parts of the township is a light sand mixed with stones and gravel in most places and is unsuitable for cultivation. The swampy portions are covered with a layer of peaty moss of varying thickness and generally have a sandy subsoil. They would have to be drained before cultivation could be successfully carried on. The whole of sections 1, 12, 13, 24, 25, 19, 30, 31 and 32, the easterly portions of sections 2, 11, 14, 16 and 23, and the westerly portions of sections 20 and 29 are swampy and covered with tamarack and spruce and are nearly level. The remainder of the township is rolling. A range of low hills passes through this township in a northeasterly and southwesterly direction, beginning at the southwest corner and passing out at the northeast corner of the township. These hills are covered with a sparse growth of small jackpine. About sixty-five per cent of the township is covered with wood, about twenty-three per cent with scrub, consisting of jackpine, willow and poplar and the remaining twelve per cent is either open or semi-open. The timber remaining in the township consists of tamarack, spruce and jackpine and a few cedar trees in sections 1 and 2, nearly all of which are under ten inches in diameter and not good enough for boards. Railroad ties could be made from the tamarack in sections 25, 24, 13, 12, 1, and 2 in the east and in sections 18, 19, 20, 29, 30, 31 and 32 in the west. The portions of this timber unsuitable for ties could be made into cordwood. Some cordwood could also be cut in sections 17, 16, 15, 14, 11, 10 and 9. A few hay meadows are scattered over the township and they produce a small crop of coarse hay. All the water is fresh and is plentiful and permanent in the swamps, but entirely absent in the higher parts of the township. There are no permanent streams. During the season I was operating in this township the climate was good; there were hot days and cool nights with no summer frosts. There was sufficient rain. Fuel consisting of tamarack, spruce or jackpine can be secured in abundance in all portions of the township. No coal or lignite veins are known to exist in the township. No exposures of rock in place and no valuable economic minerals were seen. Bear and moose are plentiful, and some few traces of deer were seen. Of the smaller game there are some ruffed grouse, prairie chicken and a

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 10—Continued.

great many rabbits. Timber wolves and coyotes are quite numerous.—*H. S. Holcroft, D.L.S., 1906.*

7.—This township is most easily reached by the Dawson road from Ste. Anne which passes through sections 33, 34, 35 and 36, or by taking the Sprague trail, which leaves the Dawson road in township 8, range 9, the southerly portion of the township may be reached. Both the Dawson and Sprague roads are fairly good for travelling on. About two-thirds of this township is of a light sandy and stony soil, very little of which is suitable for agricultural purposes as it is too light and dry. The remaining one-third is swampy and covered to a considerable depth with a peaty moss, all of which, at present, is too wet for cultivation and even if drained would be of very little agricultural value. The higher portions are rolling and covered with a sparse growth of jackpine or scrub. The lower portions are very nearly level and are covered with a dense growth of tamarack and spruce. Sections 31, 32, 33, 29, 28, 27, 26, 20, 21, 22, 16 and 6 and the northerly portions of sections 34, 35, 36, 15, 14 and 9 and the easterly portions of sections 19, 18 and 7 and the westerly portions of sections 23 and 25 are covered with jackpine, poplar, balm of Gilead and scrub, with a few small open places. The remainder of the township is covered with a dense growth of tamarack and spruce. About seventy-two per cent of the surface is timbered, about twenty per cent scrub and the remaining eight per cent is open or semi-open. But very little timber suitable for boards is left in this township. In the westerly portion of sections 7, 18, 19 and 30 there are a few trees over ten inches in diameter. The northern and central portions of the township are covered with small jackpine and some poplar, all of which is small and suitable only for fuel. The southeasterly portion of the township and the westerly parts of sections 7, 18, 19 and 30 are covered with tamarack and spruce, some of which would make railroad ties. The remainder is suitable only for fuel, of which there is a large quantity. Very little hay could be cut in this township. A few small hay meadows are scattered throughout the township, but the growth of grass on these is light and stunted. Water can be got near the surface in all sections except sections 31, 32, 29 and 17, in which sections it would be necessary to go to some depth for it. The supply would be sufficient and permanent. All the water is fresh. No running streams are in this township. None of the land is liable to be flooded. No head of water is obtainable in this township. The climate is good; sufficient rain, much sunshine, cool nights and no summer frosts occur. Fuel consisting of tamarack, spruce, jackpine and some poplar is plentifully distributed over the whole of the township. No coal or lignite veins were discovered. No stone in place was encountered. No minerals of economic value were seen. Moose, bear, and red deer were plentiful. Prairie chicken and partridge were found in small numbers. No traces of other game were seen.—*H. S. Holcroft, D.L.S., 1906.*

8.—This township is most easily reached from Ste. Anne station by the Dawson road. The travelling on this road is fairly good with the exception of about three-quarters of a mile of corduroy. The whole southwesterly quarter of the township and the westerly part of sections 10 and 15 are composed of sand with boulders in most places. In places the surface is covered with a thin layer of partially decomposed vegetable matter, but this layer is too thin to aid appreciably in enriching the soil. The remainder of the township is covered with a thick layer of peaty moss, in the swamps, and with matted grass roots in the marshes. All of the swamps are too wet to be cultivated until drained. If well drained the swamps and marshes would probably produce the usual vegetables and cereals of the district. The sandy portions are of too light a soil and are too dry to produce much growth. The southwestern portion of the township is rolling. The remainder is nearly level. With the exception of the marshes the whole of the township is wooded or is covered with scrub. Marshes and hay meadows occupy about eight per cent of the surface. Woods or

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 10—Continued.

scrub, mainly woods, cover the remaining ninety-two per cent. The larger marshes are located in sections 13, 14, 15, 22 and 23 and the northern parts of sections 31, 32 and 33, but very small marshes and hay meadows are located at intervals over all the township. A large broken marsh covered in many places with scattered willow and scrub tamarack extends throughout portions of sections 13, 14, 15, 22, 23 and 24. Located at intervals throughout the remainder of the township, with the above mentioned exception of the southwest quarter, are many marshes varying from two or three chains to fifteen or twenty chains in width. About twelve per cent of the township is covered with scrub, generally willow or scrub tamarack, spruce, poplar and balm of Gilead, with a small amount of scrub jackpine. This scrub is well distributed over the township. The best of the original timber in this township has been removed, but there yet remains a small quantity of spruce and tamarack that would make boards. Sections 4, 5, 6, 7, 8, 9, 15, 16, 17 and 18 contain practically only jackpine and poplar, all too small for boards. There is a small quantity of cedar averaging about seven inches in diameter in sections 28, 29, 30, 31, 32 and 33. Tamarack and spruce are well distributed over all the northern and eastern portions of the township, tamarack being the most plentiful. Throughout the township the tamarack would average about seven or eight inches in diameter and the spruce about six or seven inches. There is very little timber over ten inches in diameter. A portable sawmill, not at present in use, is in the northwest quarter of section 16. But little hay could at present be cut in this township. In sections 12, 13, 17 and 18 about ten tons of hay could be cut annually. A few small hay meadows are scattered throughout the township, but these produce only a very small amount of grass suitable for hay. All the water in the township is fresh. In sections 4, 5, 6, 7, 8, 9, 16, 17 and 18 some difficulty might be experienced in getting water in a very dry season, but elsewhere in the township water is permanent and can always be obtained by digging. Windy lake, a small body of fresh water about sixty acres in area, lies in sections 31 and 32, and a part of Oak lake, also fresh water, in sections 32 and 33. One small stream of clear water about three feet wide and six inches deep flows into Windy lake in section 31. This is the only running water in the township. None of the land is liable to be flooded to a serious extent, but a great deal of the lower lands would have to be drained before commencing successful agricultural operations. There is no water-power in this township. The climate during the season of operation was reasonably equable, with the exception of a fairly severe frost on the night of July 30, 1906. Fuel consisting of tamarack, jackpine, poplar, spruce and balm of Gilead is abundant in all parts of the township. No coal or lignite veins were encountered. No stone in place was encountered in this township, but boulders and stones, mostly granite, are scattered over nearly the whole township, especially in the southwest portion. No minerals of economic value were seen. Moose and bear are quite numerous. A few black partridge and ruffed grouse were seen, also a few traces of deer. No traces of other game were seen.—*H. S. Holcroft, D.L.S., 1906.*

9.—I reached this township from township 9, range 9, by the old logging trail which crosses sections 7 and 18. It was in excellent condition at the time of the survey and extended eastward across the south part of sections 20 and 21 to the southwest corner of section 22. Thence I cut a trail through sections 15, 14 and 12 to the east boundary of the township. The soil is either moss, black loam or sand. The moss occurs in the marshes and is a peaty moss extending over eighteen inches in depth. The black loam occurs in the spruce and tamarack muskegs and when drained should be splendid agricultural land. This comprises the largest part of the township. The sand is found associated with the poplar and willow bush and is valueless for agriculture, containing also many stones and boulders. The surface is everywhere covered with bush. The northern half of the township is covered

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 10—Continued.

with tamarack and spruce. Sections 18, 17, 16, 9, 8 and 7 are covered with poplar and willow with scattered jackpine and spruce, and the balance of the township with spruce and tamarack. The township has all been cut over, and the buildings of Nolin's old mill are still standing in the southwest corner of section 20. There is but very little timber large enough to cut at present, it being nearly all under ten inches in diameter. It should, however, in a few years grow to a valuable size if not destroyed by fire. A small quantity of marsh grass may be obtained in a hay marsh along the north boundary of section 16 and also in the south part of section 14; also a small amount of blue grass along the banks of Brokenhead river in section 36. A branch of Brokenhead river crosses section 36. Where it leaves the township it is thirteen links wide, 3 feet deep and flows at two miles per hour. The land is not liable to be flooded. Fresh water of excellent quality is to be found everywhere in the township. No water-power is available. The climate is moderate with no frosts at the time of the survey (July). An abundance of fuel is to be found in the form of dead trees. No stone quarries or minerals were found. The game is bear, moose and deer.—*J. L. R. Parsons, D.L.S., 1906.*

14.—This township is crossed by the Lac due Bonnet branch of the Canadian Pacific railway. There is a wood siding on section 28 where J. D. McArthur has a log and wood camp. The Winnipeg Electric Railway company have cleared a right-of way 1·50 chains wide across the township on which they have erected a pole line for the transmission of electrical energy to Winnipeg. A fairly good road has also been made along this right-of-way. The greater part of the township is swamp or sand ridge which at present is unfit for cultivation. There are a few quarter sections of fairly good land in the northeasterly part of the township and near the Six-mile siding on the railway. The timber is chiefly tamarack and spruce, a great deal of which has been cut out for logs and wood by J. D. McArthur, who, I believe, has a limit extending over the whole township. On the higher ground where the timber has not been burned off completely, there is some heavy poplar and birch. There are no hay lands, running streams, stone quarries, minerals or coal that I am aware of. Game, consisting of rabbits, partridge, chickens, jumping deer and moose, is plentiful. —*Geo. H. Watt, D.L.S., 1906.*

15.—The southeasterly corner of this township is crossed by the Lac du Bonnet branch of the Canadian Pacific railway, and there is a good sleigh road from Lac du Bonnet station leading to section 25 of the township. A large proportion of the township is bog and swamp, but there are some dry ridges. The soil on the ridges is generally fair with sand or clay subsoil, except in the southerly part of the township where the subsoil is stony clay or hardpan. The heavy dead standing and fallen timber and thick underbrush are conditions that will keep settlers out for some time. The timber on the ridges has been poplar, spruce, birch and ash, but the greater part has been fire-killed and a thick growth of underbrush has sprung up. In the swamps and muskegs the timber is tamarack and spruce, mostly small, from eight inches in diameter down. The largest trees have all been cut and taken out for logs. There are meadows where hay has been cut, but the hay is coarse. The water in the swamps is fresh. There is only one sluggish stream in the eastern part of the township. There is no drainage at present, but the township could be easily drained into Winnipeg river. I saw no minerals, coal or stone of any value. Moose, timber wolves, bears, chickens and partridge are plentiful.—*Geo. H. Watt, D.L.S., 1906.*

Range 11.

1.—The soil in this township is mostly third-class, although there are a few quarter sections in the western part of the township that rank as second class, the

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 11—Continued.

soil being a rich black loam and clay subsoil. All of the land is covered with heavy bush, consisting principally of spruce and tamarack from five inches to ten inches in diameter, with a few small bluffs of pine and poplar averaging about seven inches in diameter. There is no hay to be found, but in the township to the east a considerable amount of hay can be secured. There are no streams or creeks in the township, but water can be obtained in almost any part of the township either in the swamps or by digging a few feet. The climate is the general Manitoba climate, with no indications of summer frosts. Fuel can be had in unlimited quantities all through this section of country, consisting principally of spruce, tamarack, jackpine and poplar. There are no coal or lignite veins, stone quarries or minerals to be found. Moose and black bear are almost the only kinds of game in this district. Good trails from the northern part of this township to the stations of Badger and Vassar to the north on the main line of the Canadian Northern railway, and to Pine Valley, a station on the Emerson-Vassar section of the Canadian Northern railway, just being erected in the township to the east. In all these places there are schools, postoffices and small country stores. The Emerson-Vassar branch of the Canadian Northern railway runs through the northern part of the township.—*John Molloy, D.L.S., 1906.*

2. Nearly all the land in this township is of third and fourth class quality, being mostly sand having about two inches of sandy loam which is unfit for producing crops. The land is covered mostly with jackpine scrub about six feet high, although there is more heavy bush in the southern portion of the township, consisting of jackpine about seven inches in diameter and some spruce and tamarack, mostly dry, about five inches in diameter scattered throughout the township. There is very little hay to be found, but it could be obtained in a few places by clearing the bush off. All of the water is of first class quality, and the supply is sufficient and permanent. It can be had by digging in almost any part of the township, except on the jackpine ridges, where it might be a little difficult to obtain it. There are no streams to be found. The climate is the general Manitoba climate, without any summer frosts. Enough fuel for present purposes can be had in the township, and the surrounding townships are well supplied with wood for fuel, consisting of spruce, tamarack, jackpine and cedar. There are no coal or lignite veins, minerals or stone quarries to be found. Game consisting of moose, deer and black bear are very plentiful all through this section of the country. A good trail passing through the eastern part of the township runs from Badger, a station on the Ontario division of the Canadian Northern railway on section 6, township 3, range 12, to the settlement of Pine Valley in section 20, township 1, range 12, where the Emerson-Vassar branch of the Canadian Northern railway passes. There is a postoffice and store in both these places, as well as a school at the settlement of Pine Valley.—*John Molloy, D.L.S., 1906.*

6.—The soil in this township if it were dry would be nearly all black loam, but as all the township with the exception of parts of sections 35, 34, 33, 27 and 28, which are sandy, consists of tamarack, muskeg and almost impassable floating bog, the soil is thereby rendered useless. The greater part of the township is covered with bush except in the southeastern part, which consists largely of floating bog with a low willow scrub. The timber varies from three to ten inches in diameter, all tamarack, with the exception of a small quantity of jackpine in the northeastern corner, and is equally distributed throughout the township. There are no hay sloughs to be found in the township, and very little hay to be had in this district. Water can be had in any part of the township without digging, and at any time of the year. There are no streams or creeks of any kind to be found. The climate is the general Manitoba climate without any indications of summer frosts. Fuel can be had all through this district, consisting principally of tamarack and spruce. No stone quarries, coal or

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 11—Continued.

lignite veins or minerals were found. Black bear and moose are very plentiful all through this section of country and are about the only kind of game to be found. A trail leading to Woodridge and Ste. Anne passes through the township to the west, and is always in good condition, being along the sand ridges, but it is impossible to get a team or wagon into the township in summer. I was, therefore, obliged to pack all my tents and provisions into the township from section 24 in the township to the west.—*John Molloy, D.L.S., 1906.*

7.—This township may be most conveniently reached by wagon road from Ste. Anne station on the Canadian Northern railway, from which place it is distant only about twenty-five miles. The road leading from Ste. Anne is that known as the old 'Dawson road' and is well travelled as far as Brokenhead river, a distance of sixteen miles. The township may also be reached by a wagon road from Bedford, another station on the same railway, and the distance is considerably less from this point, though Ste. Anne is the preferable supply station. The soil of this township is composed chiefly of sand on the higher portions and black muck or peat in the swamps, and almost the entire township is underlaid by sand, in some places mixed with gravel. Outside of Whitemouth river, which flows northerly through the eastern part of the township, no water was found upon the surface during the time of the survey, but anywhere throughout the township good water could be found by digging to a depth of from three to six feet. The higher portions of the township being composed entirely of sand are of little value, unless perhaps for the raising of potatoes, but the swamps when drained will probably be suited to general agriculture. Almost the entire surface of this township is covered by a growth of scrubby timber; no prairie of any account being found. The timber is of comparatively little value, small black spruce predominating in the swamps and jackpine on the sand ridges. A few tamarack are found sufficiently large for milling, and some good-sized white poplar occur, but as the greater portion of the township had been visited by fire not many years ago the existing forest is mostly young and the small trees formed into thickets of poplar, spruce, tamarack, &c. The jackpine does not seem to have been affected to the same extent as the other trees by the fire, and is therefore found of larger size, but because of its stunted, gnarly nature is unsuited for the manufacture of lumber. Some marsh hay is found in various sections of this township, notably sections 7, 8, 9, 15, 16, 17, 18, 19, 20, 21, 28, 29, 30, 32 and 33. It is of the quality commonly found in sloughs and marshes and when cut in proper season makes good feed for horses or cattle. Whitemouth river affords the chief surface supply of water on this township and is composed of good fresh water. Good water may, however, be found almost any place in the township by sinking wells to a depth of a very few feet. For the use of my men and horses I usually found an abundance at a depth of about three feet, and never found it necessary to sink more than seven feet. The water level might, however, vary very considerably during different years and seasons, the present year having been a very dry one. Whitemouth river, which in this township has an average current of only about one mile an hour, is not capable of furnishing any significant water-power. Besides the volume of the stream is quite small in this locality. The locality of this township being so near Winnipeg, the climatic conditions are similar and are, therefore, on record at the meteorological office. This township being thickly wooded with various kinds of timber, there is an abundant local fuel supply. No coal is known to exist in the locality. No stone quarries are known upon the township. No minerals are known to occur. Large game, particularly moose, were observed to be common in this township and vicinity. White-tailed jumping deer, black bears, lynx, wildcats, foxes and porcupines were also met with and are common in the locality. Few water fowls were observed, but prairie

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 11—Continued.

hens. ruffed grouse and spruce grouse were common. Whitefish, pike and pickerel are found in Whitemouth river.—*J. W. Tyrrell, D.L.S., 1906.*

8.—This township may be most conviently reached by wagon road from Ste. Anne station on the Canadian Northern railway, from which place it is distant only about twenty-five miles. The road leading from Ste. Anne is that known as the old 'Dawson road' and is well travelled as far as Brokenhead river—a distance of sixteen miles. The township may also be reached by a wagon road from Bedford, another station on the same railway, and the distance is slightly less from this point, though Ste. Anne is the preferable supply station. The soil of this township is composed chiefly of sand on the higher portions and black muck or peat in the swamps, and almost the entire township is underlaid with sand, in some places mixed with gravel. The sandy sections of the township are of little value unless perhaps for the raising of potatoes, but the swampy lands being composed of a rich black muck, will, when drained, probably be suited for general agriculture. Almost the entire surface of this township is covered with a thick growth of small timber, only two or three small prairie spots having been found. The timber of this township is of comparatively little value, being small and unsuited for milling, with the exception of a few scattered tamarack. The abundance of the various trees is reperesented by the order in which they are named following : black spruce, white poplar, jackpine, tamarack, balsam, willow, cedar, birch and alder. The greater part of the township has evidently been swept by fire not many years ago, causing the existing forest trees to be young and small. The amount of natural hay growing upon this township is small, but meadows were noted upon the following sections : 1, 2, 3, 4, 9, 10, 11, 12, 14, 15, 16, 22, 27, 28, 31 and 32. Many of the above being very small. The quality is that of the ordinary marsh hay, which when cut in proper season makes fairly good fodder. This township contains no surface supply of water other than that found in the marshes, but by the sinking of wells plenty of good water may be obtained from the underlying sand and gravel beds. The amount of water in the marshes, and also the depth of water level in the soil no doubt varies very much from season to season and year to year. There are no water-powers. The locality of this township being so near to Winnipeg, the climatic conditions are similar—very cold in winter and hot in summer, and subject to very sudden changes. No summer frosts were experienced. Fuel in the form of various kinds of timber is abundant throughout the whole district. No stone quarries were seen. No minerals are known to occur upon this township. Large game, particularly moose, were observed to be common in this township and vicinity. White-tailed jumping deer, black bears, lynx, wildcats, foxes and porcupines were also met with and are common in the locality. Few water fowls were observed, but ruffed grouse and spruce grouse were plentiful and a few prairie hens were seen. Whitefish, pickerel and pike are found in Whitemouth river in the township to the south and east.—*J. W. Tyrrell, D.L.S., 1906.*

9.—This township was reached by my own trail from township 9, range 11, which enters the township in section 7 ; thence runs northerly to section 18, thence easterly and northeasterly to the northeast corner of section 17, thence easterly along the north boundaries of sections 16 and 15 to its end, 20 chains west of the northeast corner of section 15. The soil in this township is sand, black loam and moss, the sand (with boulders), occurring in the parts timbered with poplar and willow ; the black loam in the spruce and tamarack muskegs and moss in the very wet muskegs. At present the soil is of no use whatever, but if the country can be drained, the areas of black loam should prove to be very rich lands. The surface is everywhere wooded, except a large open muskeg comprising section 25, east half section 26, northeast quarter section 23 and north half of section 24. The timber

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 11—Continued.

is very much mixed in this township, the marshes and muskegs (covered with spruce and tamarack) being separated by many small sand ridges supporting poplar and willow. There is no timber over ten inches in diameter, except that in a small area in the east part of section 1 and the southeast quarter of section 12 which contains some good tamarack, spruce and cedar. This, however, was cut over a number of years ago and the best of it taken out. A small amount of blue grass occurs on the banks of the branch of Brokenhead river which crosses sections 16, 17, 20, 29 and 30. Water of excellent quality is everywhere abundant. The branch of Brokenhead river which crosses the township has an average width of 20 links, depth of one and one-half feet and flow of one and one-half miles per hour, and its water is fresh. It runs in a well defined valley and the land is not liable to be flooded. The creek bed is a little below the general level of the township and could be used to drain the land in its immediate vicinity. No water-power is available. The climate is moderate, with no summer frosts at the time of the survey (July). Fuel is everywhere plentiful in the form of dead trees. There are no stone quarries or minerals. The game is moose and bear. *—J. L. R. Parsons, D.L.S., 1906.*

Range 12.

2. The soil in this township is nearly all third and fourth class, as it consists principally of sand with a sandy or gravel subsoil. It is almost useless for farming purposes. Nearly all the surface is covered with bush and scrub consisting principally of jackpine, spruce and tamarack from two inches to eight inches in diameter. There is scarcely any hay to be found in this township. The water is all of first-class quality, and is very plentiful in the swamps, but is difficult to get, even by digging, on the sand ridges. The land is not liable to be flooded. Fuel is very plentiful all through this district, consisting principally of jackpine, spruce and tamarack. There are no stone quarries, coal or lignite veins or minerals to be found. The principal game found is black bear, moose and deer. The township is well traversed with trails running to Pine Valley to the south, where there is a large settlement, and to the stations of Vassar and Badger, on the main line of the Canadian Northern railway, which passes through the northern part of the township. There are small stores and postoffices in these places, but no schools.*—John Molloy, D.L.S., 1906.*

3.—The northern part of this township is almost useless for farming purposes, as it consists mostly of sand ridges and swamps. The soil in the swamps is a black loam, and would be good agricultural land if cleared and drained. The surface is mostly heavily timbered, the eastern part being covered with spruce and tamarack from three inches to eight inches in diameter, and the western part with jackpine from two to eight inches in diameter. All the water is first-class quality, and is plentiful, especially in the swamps, where it can be had at any time of the year without digging. There are no water-powers in the township. The climate is the general Manitoba climate, with no indications of summer frosts. Fuel is very plentiful all through this section of country, consisting principally of spruce, tamarack and jackpine. There are no coal or lignite veins in the township, and no stone quarries or minerals. Game consisting of bear, moose and deer are very plentiful all through the district. The main line of the Canadian Northern railway passes through section 6, where the station of Badger is situated. At Badger there is a store and postoffice. The township is well crossed with trails running to the line of railway, which have been used for hauling out wood and lumber.*—John Molloy, D.L.S., 1906.*

6. There is very little land in this township fit for farming purposes, as it is mostly covered with spruce and tamarack. A few quarter-sections along the northern tier of sections are not quite as wet as the remaining part of the township. Sections

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 12—Continued.

3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 18, 19 and 30 are almost useless for anything, as they are nearly all covered with tamarack bluffs about three inches diameter, low willow scrub and almost impassable floating bog. The land along the banks of Whitemouth river, which enters the township on the east boundary of section 24 and leaves the township on the north boundary of section 33, is high and dry, mostly covered with poplar and thick willows, but only extends for about ten chains from the bank. The river has an average width of about forty feet and an average depth of about two and a half feet, but seems to get much deeper and wider as it leaves the township. A small stream which first appears on section 6 and passes through sections 7, 8, 17, 16 and 21, joins Whitemouth river in section 28. The greater part of the township is covered with spruce and tamarack from three to ten inches in diameter, except along Whitemouth river, where the timber is poplar, elm, birch and balsam. The only hay to be found is in small sloughs along Whitemouth river, and a considerable quantity along the creek in the sections above mentioned. Plenty of water can be had in any part of the township without digging. The land is not liable to be flooded from Whitemouth river. There are no waterfalls or rapids from which power could be developed. The climate is the general Manitoba climate, without any indications of summer frosts. Fuel can be had in large quantities all through this section of country, consisting principally of spruce and tamarack. There are no stone quarries, coal or lignite veins or minerals of any kind to be found. Moose and black bear are very plentiful through this district, and are about the only kind of game to be had. Dawson trail, which passes three or four miles to the north, is the nearest trail, but there is no trail leading into the township.—*John Molloy, D.L.S., 1906.*

7.—This township may be conveniently reached by wagon road from Ste. Anne station on the Canadian Northern railway, from which place it is distant by trail about thirty-five miles. The road leading from Ste. Anne is that known as the old 'Dawson road,' and is well travelled as far as Brokenhead river, a distance of about sixteen miles. The township may also be reached by a wagon road from Bedford, another station on the same railway, and the distance from this point is somewhat less, though Ste. Anne is probably the better supply station. The soil of this township is composed chiefly of black muck on the surface of the low lands with sandy subsoil, and upon the higher portions which are characterized as jackpine ridges both surface and subsoil are composed of sand, in some places, particularly in the northwestern part of the township toward the banks of Brokenhead river—mixed with gravel and boulders. This river cuts through sections 5, 8, 7 and 31, whilst a small tributary of the same traverses sections 3, 10, 9 and 8, affording a good outlet for drainage, but until artificial drainage is employed to supplement the natural system but little of this township will be suited for agricultural purposes. The higher portions composed of sandy ridges may be suitable for the growing of root crops—such as potatoes. Almost the entire surface of this township is covered by a growth of small but in most places dense timber, no prairie being found. The timber of this township is of comparatively little value, fire having destroyed the forest not very many years ago. The existing forest is, therefore, largely composed of young trees entirely too small for milling purposes—except in spots where the fire had not reached. The several varieties of timber growing upon this township are given below in the order of their abundance: black spruce, jackpine, white poplar, tamarack, willow, alder, cedar, birch, ash, elm and balsam. A very limited amount of hay is found upon this township, as the surface is almost entirely covered by timber and scrub. Small hay marshes occur, however, upon the following sections: 5, 6, 23, 24, 25, 26, 27, 28, 31, 32, 33 and 36. This township is fairly well supplied with fresh water by Whitemouth river, which flows through sections 5, 8, 7 and 31, by a small tributary of the same which traverses sections 3, 10, 9 and 8, and by two small fresh

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 12—Continued.

water lakes occupying a large part of section 27. In addition to these supplies good water may be found almost any place throughout the township by sinking wells to a depth of only a very few feet. It was from such latter source that I supplied my camp with water during the prosecution of survey, the season having been an unusually dry one. Whitemouth river, which in this township has a current of only about one mile an hour, is not capable of producing any significant water-power. Besides the volume of the stream in this locality is quite small. The locality of this township being so near Winnipeg, the climatic conditions are similar, very cold in winter, hot in summer and subject to very sudden changes of temperature. This township being thickly wooded with various kinds of timber, possesses an abundant supply of fuel in that form. No coal is known to exist in the locality. No stone quarries are known to occur upon the township. No minerals of economic value are known to occur upon the township. Large game, particularly moose, were observed to be common in this township and vicinity. White-tailed or jumping deer, black bears, lynx, wildcats, foxes and porcupines were also met with and are common in the district. Very few water fowl were seen, but ruffed grouse and spruce grouse were plentiful throughout the woods, and a few prairie hens were seen in the vicinity. Whitefish, pickerel and pike as well as some other varieties of good fish are found in more or less abundance in the waters of Whitemouth river.—*J. W. Tyrrell, D.L.S., 1906.*

12.—Nearly all the land in this township that is not in the muskeg is of first-class quality, being either a sandy or black loam with a clay subsoil. The soil in the muskeg is black and would make excellent hay land if drained. The greater part of the northwestern part of the township consists of muskeg and swamp which is covered for the greater part with water averaging about one foot deep in the spring of the year. Bog river, a stream about thirty-five feet wide and ten feet deep, enters the township in section 2 and flows northwesterly up to the southwest quarter of section 14, where it loses itself and spreads out into muskeg. The portion of the township which does not consist of open muskeg is covered with bush consisting of spruce and poplar averaging eight inches diameter, and thick scrub, brulé and windfall. There is considerable hay to be found along the edge of the muskeg and banks of the river. The water is all first-class in the river and muskeg, as well as what can be had by digging from five to eight feet. There are no water-powers to be had. The climate is the general Manitoba climate, without any summer frosts. Fuel is very plentiful in this district, consisting of spruce, poplar and tamarack. There are no stone quarries, coal or lignite veins to be found. A few surface stones are to be found on sections 36 and 25. Game, consisting of moose, black bear and deer are very plentiful. The main line of the Canadian Pacific railway passes about two miles to the south. The village of Whitemouth is situated on section 36 in township 11, range 11, where there is a station, two general stores, postoffice, churches and school, and having a population of about four hundred people. The townships to the south and west are well settled by well-to-do settlers. A trail leading to Whitemouth enters the township in section 4.—*John Molloy, D.L.S., 1906.*

13.—Nearly all the land in this township is of third and fourth class, as it consists principally of spruce and tamarack swamps and muskegs, with low willow scrub. It is impossible to drive into the township except in the northern part along the south shore of Winnipeg river, where the land is somewhat higher and in places dry. The timber consists principally of spruce and tamarack, being from three inches to twelve inches in diameter, and in a few places in the eastern part jackpine and poplar are to be found. There is no hay to be found, but in the townships to the west and south, hay can be had in large quantities. Water, which can be obtained in almost any portion of the township, is of first-class quality. The water in Winnipeg river is of the very best. Along this river there are numerous rapids and waterfalls where

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 12—Continued.

thousands of horse-power can be developed. The climate is the general Manitoba climate with no indications of summer frosts. Fuel is very plentiful all through this district, consisting principally of spruce, tamarack, poplar and jackpine. There are no stone quarries, coal or lignite veins to be found, but in the north and east portions of the township surface stones are very plentiful, consisting principally of boulders. Moose is about the only game to be found. There are good trails in the township to the west leading to the village of Whitemouth on the main line of the Canadian Pacific railway situated on section 36, township 11, range 11, where there are schools, stores and postoffices.—*John Molloy, D.L.S., 1906.*

14.—The greater portion of this township is useless for farming purposes as there is scarcely any alluvial soil, nearly all the land being covered with stones and large boulders and rocks. The whole of the township is covered with bush, consisting of spruce, tamarack, poplar, jackpine, birch and underbrush, the average diameter being about eight inches and being equally distributed over the township. There is no hay land to be found in the township or in the adjoining townships. The water is all of first-class quality, both in Winnipeg river, Lee channel and the swamps. The land is not liable to be flooded. There are a number of rapids along Winnipeg river in this township, which could be utilized for water-powers and could be further developed by the construction of dams whereby thousands of horse-power would be available. The climate is the general Manitoba climate with no indications of summer frosts. Fuel, consisting of spruce, tamarack, poplar, jackpine and birch can be had in large quantities all through this district. Nearly all the township is covered with stone, consisting mostly of boulders. There are no minerals, coal or lignite veins to be found. Game, consisting of moose, deer and black bear are very plentiful. There is a corduroy road from Winnipeg river at Lac du Bonnet station on the Canadian Pacific railway, running through sections 31 and 32 of this township and then south along Pinawa channel to section 11.—*John Molloy, D.L.S., 1906.*

Range 13.

3. The west portion of the township is chiefly clay with more or less sand ; the other portion is sandy soil with, in some places, a mixture of clay in the subsoil. I would not consider the soil to be suitable for agricultural purposes except for hay and oats. The surface is level and is timbered with spruce, poplar, tamarack, balm of Gilead, birch and some balsam. Sections 2, 3, 4 and 5 are very well timbered with spruce, poplar, birch, balm of Gilead and tamarack up to twenty inches in diameter, considerable of which would be suitable for lumber and timber. The northerly part of the township is covered chiefly with poplar and balm of Gilead and the swamps with spruce and tamarack four inches to ten inches in diameter. Spruce is scattered throughout the township, and in the high land is generally from eight inches to fifteen inches in diameter. There is some small cedar along Mud creek in the southwest part of the township. There are some small meadows through the township and some larger ones along the shores of Whitemouth lake towards the north part of the township. The water throughout the township is fairly good and has very little, if any, alkali. That in Whitemouth lake is not as fresh as in the sloughs and creeks. There are no water-powers in the township, as there are no streams of any size, and as the country is level. The climate is good, there being no summer frosts to damage fruit or grain. Strawberries were very abundant, growing all through the township even amongst the heavy timber. Some gooseberries, huckleberries and a few raspberries are found. Through the latter part of May and a good part of June there was considerable rain which raised the water in the swamps and creeks. During the whole summer there is sufficient rainfall for the growth of crops of any kind. Wood is very plentiful throughout the township,

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 13—Continued.

except on a narrow strip around Whitemouth lake. No coal or lignite veins were seen in the township. No stone quarries were met with but boulders and small stones are to be found in many places throughout the township. No minerals or mineral-bearing rocks, not even outcroppings of any kind of rocks, were seen in the township. Game, such as moose, red deer, antelope, bears, wolves, foxes and small animals, is very plentiful. Ducks and geese are very numerous on Whitemouth lake. Partridges are also plentiful.—*Lewis Bolton, D.L.S., 1906.*

4.—The soil in this township is chiefly sand with very little loam, especially on the sand ridges, which are the only high lands in the township. In the swamps and muskegs there is quite a depth of moss, the subsoil being decayed vegetable matter or peat. This township is not suitable for agricultural purposes. The township is all timbered, there being no prairie. The higher parts are timbered with jackpine and some Norway pine. The pine is from six inches to sixteen inches in diameter and is fairly good for saw-logs or building timber. In the swamps, especially north of the sand ridges, there is good timber such as spruce, tamarack, poplar, balm of Gilead and a few cedar running from six inches to twenty inches in diameter. Sections 10, 11, 12, 13, 14, 15, 16, 17 and 18 are the best timbered in the township. The north half of the township is chiefly muskeg with small spruce and tamarack and is very wet and soft. Along the north side of Whitemouth lake and along Black creek there are good meadows where considerable hay has been cut this season. There are also a few small meadows throughout the township. The water is good throughout the township and there is no alkali. Black creek is the only stream in the township. It averages from four to six feet in width and about six inches in depth, though in the latter part of the summer it is considerably less. The water is fresh. The water in the muskegs is fairly good. There is no danger of the lands being flooded in this township except in a very wet season, when the low lands bordering on Whitemouth lake might be overflowed. There are no water-powers in the township, the country being too flat, and there are no streams of any size. The climate is good. There was very little summer frost and none sufficient to damage strawberries and other wild fruits, which were very abundant. Sufficient rain fell during the summer for the growth of any crop. There is plenty of wood in the township for fuel, but no coal or lignite veins were seen. No stone quarries were seen in the township but large and small rolling stones are quite plentiful, except in the muskegs. No minerals were observed nor any mineral-bearing rocks, not even outcroppings of any kind of rock were seen in the township. Game of all kinds was very plentiful, such as moose, red deer, antelope, bears, wolves and other small animals. Geese, ducks and all kinds of water fowl and partridge were also numerous.—*Lewis Bolton, D.L.S., 1906.*

5.—The land in this township is all third class. The soil is generally a black loam, but the surface is mostly swamps and muskegs, with a few high ridges which are somewhat sandy and stony. The whole of the township is covered with bush except in a few places where there is open muskeg with low willow scrub. The timber consists principally of spruce, tamarack, cedar, poplar and jackpine equally distributed throughout the township, the average diameter being about six inches. There is no hay to be found in this township, and scarcely any throughout the district. All the water is of first-class quality, and can be found in almost any part of the township either on the surface or by digging a few feet. Whitemouth river, a stream from two feet to four feet deep and about thirty feet wide, flows through the northeast corner of this township, flowing north. The climate is the general Manitoba climate, with no indications of summer frosts. Fuel is very plentiful all through this district, con-

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 1—Continued.

sisting of spruce, tamarack, jackpine, poplar and cedar. There are no stone quarries, minerals, coal or lignite veins in this district. Moose and black bear are about the only kinds of game to be found. There are no trails running through this township except a few winter trails, and they cannot be used as they run through the muskeg and open spots.—*John Molloy, D.L.S., 1906.*

7.—This township may be reached by wagon road from Ste. Anne station, on the Canadian Northern railway, from which place it is distant about forty miles. This road leading from Ste. Anne is what is known as the old 'Dawson road,' and is well travelled as far as Brokenhead river, a distance of sixteen miles. The township may also be reached by a road from Bedford, another station on the same railway. The soil of this township is composed chiefly of sand on the higher portions, and black muck or peat in the swamps, and almost the entire township possesses a subsoil of sand and gravel. The sandy sections of the township would seem to be of little value unless for the raising of potatoes or other root crops, but the swampy lands being composed of rich black muck will when drained be suited for general agriculture. The surface of this township is only slightly rolling, and is entirely covered by a forest of various descriptions of timber. It is unbroken by the presence of lakes or streams, except in the northeast corner of section 36 by Birch river. The timber of this township is of comparatively little value, being small and unsuited for milling, with the exception of a few scattered tamarack. The various kinds found growing upon this township are as follows, named in the order of their abundance:—Black spruce, jackpine, tamarack, white poplar, willow, alder, birch, balsam, cedar, ash and elm. The surface of this township is too much wooded to afford room for much hay land, still there are several hay marshes to be found, the largest extending in an easterly and westerly direction and occupying part of sections 14, 15, 16, 21 and 22. Other smaller marshes occur upon sections 11, 12, 13, 17 and 18, 19, 20 and 24. Except in the marshes the only other surface supply of water on this township is on section 36, which is crossed by Birch river—a sluggish stream 1·34 chains wide by six feet deep, where crossed by the east boundary of section 36. Fresh water may, however, be obtained almost any place in the township by the sinking of wells to the depth of only a very few feet. No water-power is known to occur upon or close to the township. The locality of this township being so close to Winnipeg, the climatic conditions are similar, very cold in winter, hot in summer and subject to sudden changes of temperature. This township being entirely wooded with various kinds of timber, possesses an abundant local supply of fuel in that form. No coal is known to occur in the locality. Some rock exposures occur upon sections 26, 34 and 36, and these being composed of granite it is probable that some good building stone may be found. No minerals of economic value are known to occur upon this township. Large game, particularly moose, were observed to be common in this township and vicinity. White-tailed or jumping deer, black bears, lynx, wildcats, foxes and porcupines were also seen. Very few water-fowls were seen, but ruffed grouse and spruce grouse were plentiful, and a few prairie chickens were seen in the vicinity. Several varieties of fish are reported to occur in more or less abundance in the waters of Birch river.—*J. W. Tyrrell, D.L.S., 1906.*

Range 14.

3.—This township was reached by a good wagon road which runs from Woodridge, which is on the Canadian Northern railway, into townships 4, ranges 13 and 14. The northerly portion, in fact, nearly all the township outside of Whitemouth lake was either swampy or muskeg. I had to abandon my team and wagon and use boats to move my party into the township. The soil is

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 14—Continued.

clay, with very little loam on the surface. That part of the township not muskeg, had the surface burnt over some years ago. killing the timber, which was chiefly cedar in this part. There is a small depth of loam with a subsoil of clay, and it would be good for agricultural purposes. But it is too flat and not high enough above the level of Whitemouth lake, and it would be liable to be flooded in wet seasons. The surface is timbered and there is no prairie. The timber is small throughout the township, averaging four inches to six inches in diameter. In the muskegs the timber is mostly dead, and small and scrubby. There is some good cedar and tamarack along the southeast side of Whitemouth lake, but it does not extend far. There is very little hay in the township, the land being too wet and marshy. The water is fairly good and is free from alkali in the small creeks and muskegs. The creeks are merely outlets from the muskegs into Whitemouth lake. There are no water-powers in the township as the country is too flat. There is not a point in the township that we visited that would be over five feet above the spring level of the lake. While surveying the township the weather was good for the season of the year, but I would consider that the township would be subject to summer frosts on account of being so low and swampy. There is abundance of wood for fuel throughout the township. No coal or lignite veins were seen. There are no stone quarries in the township. A few boulders and rolling stones were seen along the shore of Whitemouth lake and occasionally a large one in the muskegs. No minerals or mineral-bearing rocks or outcroppings of any kind of rock were seen in the township. Game of all kinds was very plentiful in the township, such as moose, red deer, bears, wolves and small animals. Geese, ducks and other water-fowl were very numerous in Whitemouth lake, and a few partridge were seen along the shore.—*Lewis Bolton, D.L.S., 1906.*

4.—This township was reached by the wagon road leading from Woodridge into townships 4, ranges 13 and 14. This wagon road crosses a succession of sand ridges running from Woodridge station on the Canadian Northern railway, to Whitemouth lake. The soil of this township is sand with very little loam except in a few places along Whitemouth river, where there is a slight mixture of clay. The high land in the township is principally sand ridges. The balance of the township is very flat and swampy, a great deal of which is very wet muskeg. The subsoil in the swamps is generally of a sandy nature. I would not consider the soil of this township suitable for agricultural purposes. The township is timbered. There is no prairie. On the sand ridges it is chiefly jackpine. In the swamps there is some poplar, spruce and tamarack, some of which is twelve inches and fourteen inches in diameter. In the muskegs it is chiefly scrubby spruce and tamarack, a great deal of which is dead. Most of the timber in the township is small, say four inches to eight inches in diameter, suitable for fuel only. In a few spots along Whitemouth river there are some spruce, tamarack, and balm of Gilead up to twelve inches in diameter. There are a few bluffs of cedar in the muskeg. There are fine hay meadows along Whitemouth river, where a number of parties have cut large quantities to feed their cattle during the winter. The water in Whitemouth river is not first-class, but can be used for domestic purposes. In the muskegs it is fairly good. There are no streams in the township except Whitemouth river, and a branch thereof rising in sections 35 and 36. This branch is larger than the outlet of Whitemouth lake, and the water is fairly good. There are no water-powers in the township, the country being too level. The climate is good and there are no summer frosts to injure small fruits such as strawberries, gooseberries, blueberries, raspberries, &c. The rainfall was sufficient for growing crops. The latter part of May and the first half of June was very showery and cloudy, with heavy thunderstorms. Wood is

TOWNSHIPS EAST OF THE PRINCIPAL MERIDIAN.

Range 14—Continued.

plentiful throughout the township, but no coal or lignite veins were seen. There are no stone quarries. Some large and small boulders were met with in the muskegs and swamps and along the river banks. No minerals or mineral-bearing rocks nor outcroppings of any kind of rock were observed in the township. Game of all kinds was very plentiful, such as moose, red deer, antelope, bears, wolves and smaller animals. Ducks, geese and other water-fowl were very numerous on Whitemouth lake.—*Lewis Bolton, D.L.S., 1906.*

5.—Nearly all the soil in this township is third class, consisting mostly of a black loam with the exception of a few ridges, where a sandy loam is found. Nearly all the township is covered with a heavy bush except in the muskegs, where a low willow scrub is found. The principal timber is spruce and tamarack, and on the ridges poplar and jackpine in addition. All the timber is equally distributed throughout the township and averages seven inches in diameter. There is no hay to be found in this section of country. All the water is of a first class quality and can be obtained easily either on the surface or by digging a very few feet. Whitemouth river, which is a stream flowing north and about thirty to forty feet wide, and two to four feet deep, flows through the southwestern corner. There are no waterfalls or water-powers to be found in the township. The climate is the general Manitoba climate, without any indication of summer frosts. Fuel is plentiful, consisting of spruce and tamarack principally, and can be obtained all through the township. There are no stone quarries, minerals, coal or lignite veins to be found in this section of country. Moose and black bear are about the only kind of game to be found, and these are very plentiful. The only trails found were winter roads and only passable during the winter months owing to the muskegs and swamps.—*John Molloy, D.L.S., 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 1.

17.—The north half of this township is chiefly high dry ground, with the exception of a marsh along the shore of Shoal lake, in section 19, and a few small marshes, which were almost dry at the time the survey was being made. It is chiefly covered with small poplar and willow with a few prairie spots. In a few places poplar up to nine inches in diameter occurs, and in the eastern part of the township considerable windfall occurs. Section 6 and a part of sections 7, 5 and 8 are timbered with poplar from four to nine inches in diameter. Shoal lake occupies part of sections 7, 18 and 19. Around the east shore of Shoal lake the soil is very wet and several open springs occur. A large swamp occupies part of sections 9, 8 and 17. There are also large wet swamps in sections 1, 2, 3 and 12. The soil in this township is chiefly black loam on a subsoil of clay, although gravel occurs in a few places, and limestone rock comes very near the surface in places. At the quarter section corner on the north boundary of section 20, for example, solid limestone was struck in the pits at a depth of five inches, and in a ditch along the road allowance on the east boundary of section 6, limestone was uncovered at a depth of about eighteen inches for a short distance. Some fencing has been done on a small scale in this township. On the northeast quarter of section 12 a few acres of excellent wheat was grown last year. Stock-raising, however, is the chief occupation of the settlers. Plenty of hay is readily obtained from the marshes which occur in the township.—*Wm. Christie, D.L.S., 1906.*

19.—This township, though stony in places, has excellent soil, and one settler stated that he had grown fifty (50) bushels of onions on a patch about fifty (50) feet square.

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 1—Continued.

He assured me that all kinds of vegetables and grain do remarkably well here. There are two or three large marshes in this township which supply hay and water for the cattle.—*Geo. A Grover ,D.L.S., 1906.*

Range 2.

18.—About one-third of this township is occupied by Shoal lake, which crosses the township from north to south. Along the west boundary of the township sections 30, 19 and 18 are swampy, with bluffs of poplar and willow. Sections 7 and 6 are drier ground lightly timbered with poplar and willow, and having numerous patches of prairie and hay land. The east half of sections 6 and 7 and the fractions of sections 5 and 8 on the shore of Shoal lake have formerly been timbered with heavier timber which has been mostly destroyed by fire. Near the shore of the lake in sections 21, 20, 29 and 30 is a fringe of woods, principally poplar and cottonwood from five to ten inches in diameter, which would furnish some good building timber. All along the shore of the lake is a strip of land of varying width from which a considerable quantity of hay is obtained. A considerable quantity of hay is also obtained from marshes and prairie patches on almost every section on the west side of the lake. Of the portion of the township east of Shoal lake, approximately the north half is high, dry land. A strip along the lake varying in width from one-half to three-quarters of a mile is timbered with poplar from four to eight inches in diameter, while the remainder is covered with scrub poplar and willow, much of which has been killed by fire. A few marshes producing hay occur in this part of the township. The settlers on the northwest and northeast quarters of section 24 have begun cultivating the land to some extent and good crops of oats were grown last year. The north half of the portion of the township east of Shoal lake is lower ground and has more marshes and muskegs, open springs occurring in places. Hay is obtained from a strip of land along the shore of Shoal lake, but very little is to be obtained elsewhere in this part of the township. The soil in this township is chiefly black loam to a depth of six to eight inches on a clay subsoil. Ducks are plentiful around Shoal lake at the time the survey was being made, and deer were reported to be quite plentiful in the vicinity.—*Wm. Christie, D.L.S., 1906.*

Range 3.

19.—The township is covered chiefly with small poplar and willow with a few oak, and has numerous marshes and sloughs; most of the latter were almost dry at the time the survey was being made. The homestead land has almost all been taken up, chiefly by Icelanders who devote their attention to stock-raising and dairying. There is plenty of grazing land almost all over the township, and the marshes produce plenty of hay in a season that is not too wet to permit of its being harvested. Stock is not allowed to winter in the open air here as is done in the provinces farther west, but is stalled and fed all winter. I saw no attempt being made at grain-growing in this township. Most of the settlers grow a few potatoes and other vegetables for their own use ; but beyond that nothing has yet been done towards cultivating the land. Shoal lake extends about three-fourths of the way across the township, entering at the southeast corner and extending northwest to section 29. There is a strip of good hay land of varying width almost all along the shore of this lake. There is practically no timber of any value, except for fence posts, &c., to be found in this township. A very limited amount of timber suitable for building might be obtained in different parts of the township, the best being on Oak island in Shoal lake, in sections 2 and 11. There is plenty of wood to provide fuel for the settlers' use for some time to come. The soil of the greater part of the township is black loam to a depth of from three to eleven inches on a subsoil of clay. The whole township is covered with drift boulders. Most

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 3—Continued.

of the settlers have obtained good water by digging wells, although in some wells the water is slightly alkaline.—*Wm. Christie, D.L.S., 1906.*

20.—The west half of this township contains a considerable amount of low swampy land, together with bluffs of poplar and willow. In the northwest quarter of the township some of the bluffs contain poplar up to nine inches in diameter. In the southwest quarter the timber is almost all scrub. The lakes shown on the plan in this part of the township are exaggerated. The eastern half of the township is somewhat higher and drier land, and is also covered with poplar and willow, the northeast quarter of the township being more thickly timbered than the southeast. A considerable portion of this half of the township has had the first crop of timber destroyed by fire, and the scrub poplar and willow that grew up in its place has also been partly killed by fire. The soil of this township is chiefly black loam on a clay subsoil. The settlers in this township devote their attention to stock-raising and dairying. I saw nothing being done in the way of grain growing. Ducks were plentiful here while the survey was being made, and some moose were also seen by members of the party.—*Wm. Christie, D.L.S., 1906.*

Range 4.

16.—This township can be easily reached by the Canadian Northern railway, which runs through the township. The soil is black loam with sand and gravel subsoil, and is adapted for dairying and raising cattle. The surface is level, and covered with bluffs of poplar, the trees averaging six inches in diameter. There is considerable hay in the marshes along lakes Manitoba and Francis. The water in the lakes and marshes is of excellent quality, being free from alkali and vegetable matter. There are no water-powers, minerals or stone quarries in the township. The climate is good, and there are no summer frosts. Poplar is obtained in sufficient quantities for fuel. Wild ducks and prairie chickens are numerous. There is a harbour of refuge under construction on section 15. An excavated channel connects Lake Manitoba with quite a large but shallow lake on section 15, and when that lake is dredged out small vessels will obtain refuge when required.—*W. J. Deans, D.L.S., 1906.*

19.—This township is of the same general character as township 19, range 3, but has on the whole less bush and, consequently, a correspondingly greater area of grazing and hay land. Much of the north half of the township has evidently been covered with timber, which has been destroyed by fire, and a second growth of small poplar and willow has sprung up in its place. The north half of the township has more prairie. The settlers in this township, as in township 19, range 3, devote themselves entirely to stock-raising and dairying, no attempt being made to cultivate the land beyond the growing of a few potatoes and other vegetables for their own use. A ditch has been dug across part of the township, draining into Lake Manitoba. It starts in section 16 and leaves the township at the north boundary of section 7. This drains a considerable area of marshy land, thus greatly increasing the area of grazing and hay land in its vicinity. The soil is chiefly black loam to a depth of from three to ten inches on a subsoil of clay. Good water may be readily obtained in any part of the township by digging or drilling wells.—*Wm. Christie, D.L.S., 1906.*

20.—This township is also covered chiefly with small poplar and willow, with numerous marshes, lakes and small patches of prairie. Much of the township has at one time been covered with heavier timber, which has been destroyed by fire, the present crop of small poplar and willow growing up in its place. The settlers are engaged in stock-raising and dairying. Plenty of hay is obtained almost all over the township. The lakes shown on the plan in the northeastern part of the township are

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 4—Continued.

greatly exaggerated. A considerable part of what is shown as water on the plan is in reality dry land covered with woods, while more of it is excellent hay land. The soil is chiefly black loam on a clay subsoil. It is very stony. Ducks were plentiful here while the survey was being made.—*Wm. Christie, D.L.S., 1906.*

23.—This township was reached from township 23, range 6, by my trail, which I cut along the south boundary of township 23, range 5. After entering the township in section 6, it runs northeasterly across sections 6, 7, 8, 17 and 16, and thence following the centre meridian, as closely as the nature of the ground permitted, to the northeast corner of section 33. This trail is very soft in many places. The soil is black loam to a depth of from four to ten inches. The subsoil varies from clay, clay and boulders to gravel. The best of it should grow all the cereals, but the land generally is best adapted for mixed farming. The surface is all bush, broken, however, by numerous marshes and muskegs. The marshes occupy about twenty per cent of the surface. The timber is chiefly black and white poplar and spruce. The spruce occurs (along with the poplar) almost entirely in the eastern half of the township. No good hay occurs. The marshes contain a coarse sour muskeg grass, but on account of the large amount of water in the marshes even this could not be harvested. Fresh water is everywhere abundant. No streams occur. At the time of the survey (November), all the marshes and muskegs were full of water. The climate is moderate. During the time of the survey winter set in, with a fall of fifteen inches of snow. This arrived before the frost, leaving the ground and marshes unfrozen. After a heavy frost, about November 18, the weather remained mild until the completion of the survey. Fuel is everywhere abundant. There are no stone quarries, and no minerals. The game is moose and elk.—*J. L. R. Parsons, D.L.S., 1906.*

24.—This township was reached from township 23, range 4, by my trail along the east boundaries of sections 4 and 9 to Sleeve lake, thence on the ice. The soil is chiefly black loam from four to six inches in depth on a clay subsoil. This should grow cereals, and is best adapted for mixed farming. The surface is bush, except where broken by Sleeve lake and the numerous large marshes surrounding and draining into Sleeve lake. Sleeve lake and the surrounding marsh covers the following sections: north half 8, 9, 10, 11, 15, 16, 17, 18, east half 19, 20, 21, south half 22, south half 28, south quarter 29, 30, 31 and 32. To the south and west of Sleeve lake the timber is poplar from four to fourteen inches in diameter, about fifty per cent of which has been fire-killed or has died of dry rot. To the north and east of Sleeve lake the timber is spruce and poplar in about equal quantities, running from four to twenty inches in diameter. There is a little tamarack in this part. No good hay occurs. The marshes contain a coarse sour muskeg grass, but these marshes were full of water at the time of the survey so that even this grass could not be cut. Fresh water is everywhere abundant. The marshes all contained fresh water, and Sleeve lake is fresh. The weather during the survey (November and December) was cold, often considerably below zero in the morning. Despite this the ground and marshes remained unfrozen, being protected by the deep snow which fell about the middle of November. Fuel is everywhere abundant. No stone quarries were found nor any minerals. The game is moose, elk and fish. In Sleeve lake are to be found great quantities of jackfish and a few English perch. Several half-breeds are now engaged in fishing there, and their catch included jackfish up to ten pounds in weight. These are teamed to Oak Point, a distance of forty miles, where they sell for two and one-half cents per pound.—*J. L. R. Parsons, D.L.S., 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 5.

18.—This township is easily reached by a good trail from Oak Point, a station on the Canadian Northern railway. The soil generally is three to four inches of black loam with subsoil of clay and stones, and is suitable for cattle-raising and dairying. Bluffs of small timber, composed of oak, poplar and willow are fairly plentiful, the oak and poplar trees averaging about six inches in diameter. Hay is very plentiful in the marshes around the edge of the lake. The water in the lake and marshes is plentiful and of good quality, being free from alkali. The climate is good, there being no summer frosts. Fuel is scarce in the township, settlers having to go long distances for it. There are no water-powers, quarries or minerals in the township. Game, consisting of wild ducks and prairie chickens, is very plentiful. There are also many fish in the lake, which is a source of income to the settlers, who catch them in the winter time and carry them to Oak Point where there is a good market for them.—*W. J. Deans, D.L.S., 1906.*

19.—This township lies on the eastern shore of Lake Manitoba and is easily reached by a good trail which runs northerly from Oak Point, a station on the Canadian Northern railway. The westerly part of the township is an extensive marsh separated from the lake by a narrow sand beach ; the rest of the township is broken by numerous hay sloughs. The soil generally is a black loam from six to eight inches deep with gravel and clay subsoil. There are numerous stony ridges running north parallel to the lake. The settlers are engaged in raising cattle and dairying. Some grain and vegetables are raised in some parts and appear to attain great perfection. There is quite a lot of poplar, though it is generally small. The settlers have to go a considerable distance for fuel. There are great quantities of hay along the marsh. The water in the marsh and lake appears to be good and free from alkali. Some seasons the water in the lake is so high that a large amount of the hay land is submerged. There are no streams in the township. There are no water-powers, stone quarries or minerals in the township. Game such as wild ducks and prairie chickens are plentiful and occasionally a deer is seen.—*W. J. Deans, D.L.S., 1906.*

19.—This township borders on Lake Manitoba, which takes off a portion of the southwest corner of the township, approximately in a line from the west boundary of section 18 to the north boundary of section 5. Along the shore of the lake is a strip, nearly two miles in width, which is almost all marsh with tall rushes, reeds, and deep bogs. The remainder of the township also contains much marshy land, together with bluffs of poplar, oak and willow. A plentiful supply of hay is obtained from these marshes. The settlers in this township devote their attention to stock-raising and dairying. A limited quantity of timber suitable for building may be obtained in this township. The soil is chiefly black loam on a subsoil of clay. An extension of the Oak Point branch of the Canadian Northern railway is surveyed through this township.—*Wm. Christie, D.L.S., 1906.*

20.—The north half of this township is covered chiefly with poplar woods broken by marshes and small patches of prairie. Much of the first crop of timber has been destroyed by fire, and a recent growth of small poplar and willow has sprung up in its place. Where the woods have escaped destruction by fire there is timber varying in size up to ten inches in diameter. In the south part of the township, sections 3, 4, 5, 6, 7, 8, 9, 10, 15 and 16, are chiefly prairie broken by marshes, hay grounds and a few small poplar bluffs. Sections 1, 2, 11, 12, 13 and 14 have less swamp and are covered to a greater extent with scrub poplar and willow. The soil is principally black loam on a clay subsoil. There appears no reason why it should not be suitable for grain growing. Stock-raising, however, occupies the attention of the settlers at present.—*Wm. Christie, D.L.S., 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 6.

19.—The township is easily reached by a good trail from Oak Point Settlement on lake Manitoba. The soil is generally a black loam with stone and clay subsoil. I think it would be suitable for cattle-raising and dairying. The township is level and broken by marshes ; a very extensive one lies in section 35. There are quite a number of bluffs of poplar and some oak, generally small but large enough for fencing and fuel. There are large quantities of hay in all parts of the township. The water in the marshes is fresh and good and unlimited in quantity. The climate is good and there are no summer frosts. There are no stone quarries, water-powers or minerals of any kind in the township. Game, such as wild duck abounds and there are great quantities of small wild fruit in the bluffs. The settlers are engaged in cattle-raising and dairying, and in winter do some fishing in the lake which abounds with whitefish, pickerel and jackfish. A good market is found at Oak Point for fish, which are shipped to various parts of Canada and the United States.—*W. J. Deans, D.L.S., 1906.*

20.—This township borders on lake Manitoba, about one-fifth of the township being taken off by the lake. Along the shore of the lake is a strip of marsh, much of which produces an excellent crop of hay. The remainder of the township is chiefly covered with woods, principally poplar, with a few oaks, broken by numerous marshes, muskegs and hay lands. There is plenty of timber in the township to satisfy the needs of the settlers for building purposes and for fuel. The soil is chiefly black loam on a clay subsoil. The settlers devote their attention chiefly to stock-raising and dairying, but a few attempts have been made at grain-growing in this township, apparently with success. I noted particularly an excellent crop of oats on section 20, and on section 32 an excellent crop of oats and barley was growing at the time the survey was being made. The extension of the Oak Point branch of the Canadian Northern railway also passes through this township.—*Wm. Christie, D.L.S., 1906.*

23.—This township was reached by my own trail from township 24, range 6, which enters the township from the north, at the northeast corner of section 33, and is in good condition. In the south it is entered by an old Indian hunting trail from Lundar. This trail, crosses section 2. It follows the marshes and muskegs, and was very soft and wet at the time of the survey. The soil is chiefly black loam from four to ten inches on a clay subsoil. The high land would grow all the cereals but it is much broken by marshes and muskegs. The surface is all timbered but has been fire-swept recently and a great deal of the timber has been killed. Many large marshes occur in the north and west parts of the township. The timber is black and white poplar and scattered spruce from 6 to 15 inches in diameter. A great deal of it has been fire-killed and of the living poplar much of it has dry rot and is useless for lumber. Hay is not plentiful in the township. The large marshes were full of water at the time of the survey (October), and were covered with a sour muskeg grass. A few scattered hay marshes occur, however, and some good marsh grass is found to the northwest of lake No. 2, but this was too wet to cut at the time of the survey. Fresh water is everywhere obtainable in the marshes and muskegs, and on the ridges by digging a few feet. A small stream enters section 4 from the south and finds its way westward through a chain of marshes to Dog lake. No water-powers occur. The climate is moderate, with only slight frosts at the time of the survey. Fuel is everywhere abundant, in the form of standing fire-killed trees and windfall. No stone quarries or minerals were found. The game is moose, elk and duck.—*J. L. R. Parsons, D.L.S., 1906.*

24.—This township was reached by my own trail along the north boundary of section 13, township 24, range 7, thence northerly through section 19, township 24, range 6, to its north boundary, thence easterly along the north boundary of sections 20 and 21,

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 7—Continued.

thence south southeasterly across sections 22 and 15, thence south along the east boundaries of sections 10 and 3. It is a fair trail. The soil is black loam of average depth of four inches, on clay subsoil. The subsoil is, in most places, mixed with stones and boulders to such an extent that only small areas could be cultivated. The township is chiefly useful for grazing. The surface is scrubby, with scattered bluffs of poplar and spruce. Only a very small amount of timber exists in the township in the form of small scattered bluffs of poplar from one to eight inches in diameter and spruce from three to eight inches in diameter. Hay of fair quality is to be found in the numerous marshes in the township. Fresh water is everywhere obtainable in the marshes, or on the ridges by digging a few feet. No streams occur. There is no water-power available. The climate is moderate, with only a few slight frosts at the time of survey (September). Fuel is to be found throughout the township in the form of windfall and fire-killed standing poplar and spruce. No stone quarries or minerals were found. The game is moose, elk, duck and prairie chicken.—*J. L. R. Parsons, D.L.S., 1906.*

Range 7.

22.—This township is well suited for mixed farming and dairying, the soil being a rich black loam with clay subsoil. The surface of the country is gently rolling, and is well timbered with poplar, some of good size, on the ridges, and interspersed with hay meadows in the depressions. This alternation, extending as it does through the township, gives plenty of building material and fuel and good feed for stock. Game was fairly plentiful, and some of the settlers take a good many fish from lake Manitoba.—*Geo. A. Grover, D.L.S., 1906.*

23.—This township was reached from Oak Point, on the Canadian Northern railway, by the trail along the northeast shore of lake Manitoba as far as Minnewakan; thence by the old 'Indian trail' to section 9, township 22, range 7, west of the principal meridian. Both of these trails were in good condition. From this point the course is northeasterly by an old hunting trail to the northeast corner of section 16, and thence by my own trail through sections 22, 23, 26 and 35 into the southeast quarter of section 2, township 23, range 7, and thence northerly through the township. The soil is chiefly black loam of a depth of from 6 to 10 inches on a clay subsoil, and is well adapted to agricultural purposes. The presence of a large number of hay marshes makes this especially a mixed farming country. The surface is everywhere covered with bush, except where the high ground is cut by numerous narrow hay marshes and muskegs, which abound in the township. The timber is chiefly black and white poplar from six to twelve inches in diameter, with scattered spruce from six to twelve inches in diameter and a few scrubby oak. The marshes and muskegs are immediately surrounded by willow. Hay is everywhere abundant in the numerous hay marshes. It is a coarse marsh grass of fair quality. Fresh water is everywhere obtainable by digging a few feet, and was to be had in all the marshes and muskegs at the time of the survey (August). A few small streams of fresh water flow westward towards Dog lake; they frequently lose themselves in the large marshes. The land is not liable to be flooded. No water-power is available. The climate is moderate, with no frosts at the time of the survey. Fuel is everywhere to be found. At the northeast corners of sections 2 and 12, limestone was encountered in the pits six inches below the surface, apparently in place, and it was found impossible to penetrate it with pick and shovel. There are no minerals. The game is moose, elk, geese and ducks.—*J. L. R. Parsons, D.L.S., 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 7—Continued.

24.—This township was reached from township 23, range 7, by my own trail past the northeast corner of section 35, township 23, range 7; thence northwesterly across sections 2 and 11, to the northeast corner of section 10; thence northerly along the east boundary of section 15; thence northwesterly into section 22. This trail is in fair condition. The soil is chiefly black loam of an average depth of eight inches on clay subsoil. It is, however, intermixed with numerous large stones and boulders in many places. The ridges are broken by many marshes, muskegs and hay marshes. The country is best adapted to mixed farming. The surface is partly timbered and partly scrubby. It has been swept by at least two fires since the original survey. The only large timber left occurs on the east half of sections 3 and 10, and in sections 4 and 9. This is black and white poplar from six to twelve inches in diameter. The balance of the township is covered with poplar two to six inches in diameter, willow and small scattered groves of spruce three to eight inches in diameter. There is only a small amount of good marsh hay in the township. The numerous marshes and muskegs were very wet at the time of the survey (September), and contain a coarse, sour variety of wire grass which my horses would not eat. The upland grazing is, however, good, there being a heavy growth of peavine almost everywhere on the ridges. An abundance of fresh water is everywhere available in the marshes and muskegs. No streams occur. There is no water-power available. Fire-killed standing trees and windfall afford excellent fuel throughout the township. There were no stone quarries or minerals found. The game is moose, elk and duck.—*J. L. R. Parsons, D.L.S., 1906.*

Range 10.

15.—This township may be reached by a road running east from Gladstone, a station on the Canadian Pacific railway and the Canadian Northern railway. The soil generally is black loam from four to six inches in depth, with subsoil of clay and gravel. The surface is undulating and broken by numerous sloughs and stony ridges. The settlers are principally engaged in dairying and cattle-raising, large quantities of hay being obtainable on the land adjoining Big Grass marsh. There are a few scattered bluffs of small poplar and willow in places throughout the township. Wood for fuel may be obtained in the townships fifteen to twenty miles north. Whitemud river flows through the southwest corner of the township. This stream averages about seventy-five links in width, is three feet deep and has a current of about three miles an hour. The water is fresh, good and permanent. There are no water-powers, stone quarries or minerals in the township. The climate is free from summer frosts. Game, such as wild ducks and prairie chickens, is plentiful.—*W. J. Deans, D.L.S., 1906.*

16.—This township may be easily reached by a road running east and north from Gladstone, a station on the Canadian Northern railway. Big Grass marsh occupies a considerable portion of the northwest corner of this township. The surface is undulating and covered with numerous bluffs of poplar and willow. The soil is black loam eight inches deep with clay and gravel subsoil. The settlers are largely engaged in raising cattle and dairying, there being an abundance of hay along Big Grass marsh and in the sloughs. There has been very little effort made at grain raising, but the soil would no doubt raise oats and barley. Vegetables do well. There are no summer frosts. The climate is the same as the rest of Manitoba. There are no water-powers, stone quarries or minerals. The principal fuel is wood, which is procurable in many places throughout the township. Wild ducks and prairie chickens are plentiful, as well as larger game, such as deer and elk. Water is very scarce and of a poor quality, being highly impregnated with decayed vegetable matter, although

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 10—Continued.

cattle appear to like it and do well on it. Wild berries and plums are plentiful in the bush.—*W. J. Deans, D.L.S., 1906.*

17.—This township may be reached by a road and trail which runs east and north from Gladstone, a station on the Canadian Northern railway. Big Grass marsh occupies a considerable portion of the westerly part of the township. The surface is undulating and broken by ridges and numerous hay sloughs. There are numerous poplar bluffs throughout the township, and clumps of willow. The poplar is large enough for fuel and building purposes. The settlers are engaged in dairying and cattle-raising, there being an abundance of hay. Water is scarce, being procurable only in the sloughs, and is of poor quality, although cattle appear to thrive on it. There are no water-powers, stone quarries, or minerals. There are numerous quarter sections which would raise grain, when brought under cultivation. All kinds of vegetables do well, and are raised in considerable quantities by the settler. There are no summer frosts, and the climate is good. Wild ducks and prairie chickens are plentiful, and larger game, such as elk, moose and deer are occasionally met with.—*W. J. Deans, D.L.S., 1906.*

Range 11.

15.—This township may be reached by a good road which runs north from Gladstone, a station on the Canadian Northern and Canadian Pacific railways. The township is level. The soil is black loam averaging twelve inches in depth with clay subsoil, except the east half which is occupied by Big Grass marsh. This marsh is nearly dry in the southerly part of the township, but there are numerous ponds and soft mud flats in the northern part. There are extensive peat beds throughout the marsh, which will no doubt in time be used for fuel. Whitemud river flows through the southeast corner of the township and drains the marsh. There are a few scattered bluffs of poplar in the western part of the township, but not sufficient for fuel, which is brought in by the railway or obtained at some distance west on the Riding mountains. The township has been settled for a number of years and all available land is under cultivation or pasturage for cattle. Extensive quantities of hay are cut in the lands adjoining Big Grass marsh. Good water is not plentiful, being confined to Whitemud river, a stream about fifty links to one chain in width, and having a current of about three miles an hour. There are no stone quarries, water-powers or minerals in the township. The climate is free from summer frosts and is well adapted for growing all kinds of early vegetables. Wild ducks and prairie chickens are plentiful.—*W. J. Deans, D.L.S., 1906.*

16.—This township can be reached by a good road which runs north from Gladstone, a station on the Canadian Northern and Canadian Pacific railways. Big Grass marsh occupies the eastern half of the township. The western half is generally low level prairie, broken by numerous small hay marshes. There are a few bluffs of small poplar and willow on the west side, but the timber is large enough for fuel or for any building purposes. There are some quarter sections in the west part which are under cultivation, growing small quantities of grain and vegetables, but the principal industry of the settlers is dairying and cattle-raising. This industry is very profitable, owing to the enormous quantities of hay which grows in the township. Water is scarce, being found only in the sloughs in Big Grass marsh. The quality is such that cattle appear to thrive well on it. There are no water-powers, stone quarries or minerals. Wood for fuel is found in the townships to the north. Prairie chickens and wild ducks are moderately plentiful. The climate is good and free from summer frosts.—*W. J. Deans, D.L.S , 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 11—Continued.

17.—This township can be easily reached by a good road which runs east from Plumas, a station on the Canadian Northern railway. Big Grass marsh occupies the eastern half of the township. The western half is undulating prairie, broken by hay sloughs, there are a number of bluffs of small poplar and willow in the west part of the township, and much larger ones north of Big Grass river, which furnish abundance of fuel for the settlers. The settlers seem to be all engaged in dairying and cattle-raising, hay being very plentiful throughout the township. Little attention is paid to the cultivation of the land, except for raising small quantities of oats and vegetables. However, there is a considerable portion of the township which would raise wheat, oats, &c. Big Grass river flows through the northern part of the township and loses itself in Big Grass marsh. This river is six to eight feet in depth, and one chain in width, with no perceptible current. The water is strongly impregnated with matter, but when boiled is good for all domestic purposes. There appears to be a sufficient quantity for all needs of the settlers. There are no water-powers, stone quarries or minerals in the township. The climate is good and free from summer frosts. Wild ducks and prairie chickens are numerous, and partridges are plentiful in the bluffs.—*W. J. Deans, D.L.S., 1906.*

18.—This township may be reached by a trail which runs easterly from Plumas, a station on the Canadian Northern railway. The surface is slightly undulating and is covered with poplar and clumps of willow. There are numerous small hay sloughs throughout the township. The soil is generally black loam with clay subsoil and is well adapted for grain-growing after the ground is cleared. The southeast corner is occupied by Big Grass marsh. The settlers are engaged in cattle-raising and dairying, there being abundance of hay in the township. Wood for fuel and building purposes is easily obtained throughout the township. The water in the sloughs is fresh and good and in sufficient quantities for the needs of the settlers. There are no water-powers, stone quarries or minerals of any description in the township. The climate is good and free from summer frosts. Wild ducks and prairie chickens are plentiful, and deer are frequently seen in the northerly portion of the township.—*W. J. Deans, D.L.S., 1906.*

Range 22.

34.—The route followed was through sections 16, 9 and 4 of township 35, range 22 and through sections 33, 34, 27 and 22 to South Duck river. The trail was very rough and through bad muskeg full of deep holes. The soil near South Duck river is fairly good and the land could be drained so that this would make good farm land. It is a loam but the subsoil is quite often rather sandy. Along the south and west side or the southwest corner some good land is found. The soil is a black loam but the surface is rather flat, so much so that the greater part of it was flooded in July. However, if this were drained it would make very good farming land and some good hay meadows. Away from the river it is nearly all swampy or muskeg and is very wet. It is of little use unless drained, which would be hard to do as the country is so flat. The surface is generally covered with scrub. Some small openings are found towards the west and south. There is no timber of any account, but a few fair-sized spruce trees, eight to ten inches in diameter are growing in the northwest corner of the township. Considerable dry standing tamarack from six to ten inches is scattered here and there over the township. Hay is fairly plentiful along the south and west sides of the township. Numerous hay meadows are found along the west side which are used by the Galicians at present. If the country were drained there would be quite large meadows available when the bush was cleared off. The hay would be only of fair quality. There are also some sloughs in the eastern part that would make hay meadows if drained. The water is all fresh and very plentiful. The only stream of any account is South

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 22—Continued.

Duck river, which is about twenty-five feet wide, two feet deep and has a current of about two miles an hour. The only wide part is where the two streams have joined about the north side of section 16; it narrows down and almost disappears in section 26. It is dammed up by beaver in several places about three feet above its usual level. The land is very liable to be flooded almost entirely except close to the wide part of the river where the banks are about five feet high and the channel is about thirty to forty feet wide. In July the greater part of the township was flooded nearly a foot deep and in some places deeper. There are no water-powers. The climate was very cold in November and December. It was 42° below zero once and often from 20° to 35° below zero. There was a great deal of snow, so much so that even, when we finished, some of the muskeg would not carry us. The frost was only in six or eight inches at the most. The only fuel is wood, but there is plenty of it and of good quality. Tamarack is the best and is scattered all over the township. No stone quarries or minerals were found. The only game seen was moose and rabbits, but there were a number of beaver in the river and the Indians were trapping lynx. The township is so flat it will not be of much use in wet years.—*W. G. McFarlane, D.L.S., 1906.*

35. The route followed into this township was from Cowan station along the south side of North Duck river by our own trail. It was rather rough on account of fallen logs, and in places it runs through grassy sloughs. We cut a road across the river in section 16 and north as far as the north chord. The river bottom has some quicksand, and the water at the ford is about three feet deep. The road north is rather rough, and when near the north chord it becomes very wet and soft, as it is all tamarack swamp. The soil is in general not very good, but there is an exception along the river. Here a good black loam and in some places a good clay subsoil is found. This would make excellent farming land. Farther back from the river it becomes very wet and swampy. Here the soil is usually a black loam about six inches deep, or the depth of the sod or moss, and usually a sandy subsoil. On some of the slight elevations covered with jackpine nothing but sand is found. Some of these parts would be too wet and others too sandy to be of much use for farming. The surface is usually scrubby, but a few large spruce and poplar trees grow along the river. In some places there is little but dry standing tamarack and windfall. The timber is chiefly spruce, with a little balsam, birch and poplar. It is from ten to twenty inches in diameter, but is not at all plentiful. It is found only near the river. Hay is fairly plentiful near the river, as there are quite a number of hay sloughs and some meadows, but these have usually considerable brush and burnt logs in them. Some of the swamps if cleared and drained would produce a considerable quantity of hay. It would be mostly of a rather coarse quality. The water is all fresh, and very plentiful and permanent. North Duck river is the only stream of any account; it is usually about thirty feet wide and on an average one and one-half feet deep. The current is about three miles an hour. It is very winding, and the banks are usually about ten feet high. Away from the river we find the country usually very level or almost flat, and nearly all of it, with the possible exception of some slight elevations covered with jackpine in sections 28 and 29, is liable to be flooded during a very wet season. The water might be about a foot deep. There are no water-powers available. The climate in October and November was very damp. We had considerable rain and a great deal of snow, some being very wet. The snowfall was so great that it kept the ground from freezing, and made it very sloppy and wet working even when comparatively frosty. The lowest temperature noted was 26 degrees below zero Fahr. Cold winds were often experienced. The only fuel found was wood. Tamarack is the best kind, and it is found in abundance over the greater part of the township. Spruce and poplar can also be had, almost anywhere. No stone quarries, and in fact very little stone of any kind was seen. No minerals were found.

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 22—Continued.

The only kind of game seen was moose and rabbits. There were also some lynx there. The township is so flat that it would be rather difficult to drain it except near the river.—*W. G. McFarlane, D.L.S., 1906.*

Range 23.

28. The route followed was almost due north from Grandview for about twelve miles, thence north and a little east going partly across country and partly following the road allowance, until we reached the south side of the township; thence by trail into it. The road was fairly good, with the exception of an occasional bad mudhole, for the first twelve miles, then it became very bad in many places. Long stretches of it are nothing but mud and water two feet deep or more, with some muskeg and a few bad creeks to cross. The trail through the township was very wet, and through a good deal of muskeg. In fact in quite a number of places we had to pack our baggage and supplies across, as the horses could scarcely get through the mud. The soil is of quite different varieties. To the south there is a great deal of muskeg and some sand, and also a few small parts of good loam. Towards the north the ground is high, and good creeks drain it. The soil there is of good quality for farming. The surface towards the south is gently rolling or flat, but at the north it is quite hilly. There is very little prairie, or in fact really none, as the open part is merely burnt off. At the south there is considerable scrub and scattered patches of spruce, tamarack and jackpine timber, but none of any great extent. Towards the north it is all heavily timbered, but will not be of use for a timber limit. There is some timber of fair size, from ten to eighteen inches in diameter. It consists of spruce, tamarack, poplar and a little jackpine, and is of fair quality but not of any great extent. Hay is very scarce and of rank slough quality. There is a little in section 10, but that is the only place noticed. Water is very abundant, and is found nearly all over the township. Much of the south part was actually flooded as well as the easterly part. In the northerly portion the water is found in good clear creeks with swift current. The water is all good and fresh, and the supply is more than sufficient and permanent. There are several good streams towards the north, not very deep or wide but with swift currents. Small water-powers might be developed from the streams to the north, but of no great value. The climate in May was usually warm, but frequent cold, windy rainstorms were experienced. No summer frosts were noticed. Fuel is very plentiful. Wood is the only kind of fuel used; it can be had almost anywhere, but is most plentiful towards the north and west where there is considerable windfall. No stone quarries or minerals were found, and no game was seen except rabbits, although deer tracks were noticed. It was possibly a very wet season, otherwise the south part of this township would show up to better advantage for farm land, while the north will take a great deal of work to clear it.—*W. G. McFarlane, D.L.S., 1906.*

32. The route followed from township 28, range 23, was by trail northeasterly to Ethelbert; thence northerly on the west side of the railway to Pine River station; thence westerly and a little south by trail into the township. The trail to Ethelbert was very bad; a great deal of muskeg and mudholes had to be passed through. From Ethelbert north to Pine river the trail runs along the gravel ridge and was good. Going westerly into the township it was again very bad, being nearly covered with water and swamps. The trail into the west part of the township is over some high hills and quite steep in places. The soil is of all varieties. Towards the southeast corner the land is swampy with a little loam and heavy clay subsoil. In some places there is deep muskeg. To the northeast it is usually very sandy and would not be of much use for farming. There is some very fair land, along the foot of the hills, which would make good farms, and also some towards the southwest corner of the

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 23—Continued.

township. The northern part, near Pine river is usually too rough for farm land and considerable stone and gravel is found there. The surface is all covered with scrub or timber with the exception of one or two places near the foot of the hills. In general the timber left now is not plentiful or very valuable as the best has been taken from the east and southeast parts of the township, by lumber companies. However, a few clumps of fair spruce and tamarack are scattered here and there throughout the township, leaving good timber for settlers. There is also some jackpine of fair size, but the large trees are found only in the northeast quarter of the township. Other jackpine, about three inches in diameter, is found in dense extensive groves in sections 19, 20 and 21 on top of the hills. Here the windfall is often piled fifteen feet high and so interwoven that one cannot walk through it. The high land is generally covered with jackpine, willow and poplar scrub. It is badly cut up by deep and steep ravines where the creek beds are found. Hay is not plentiful and little can be found except along the foot of the hills, and even then it is not plentiful but it is of fair quality. Very few hay sloughs were seen. Water was most plentiful and always good and fresh. The lower land was partly flooded and in the hills very many good clear little creeks were found. In the northern part of the township Pine river runs nearly across it. At times the river can be forded at the rapids without the least difficulty or danger, but an hour after a heavy rain starts it becomes a roaring torrent and is too swift to cross although even then it might not be more than four feet deep in places. The river would average about two feet deep and sixty or seventy feet wide when normal, and the current about five or six miles an hour, but when a heavy rain starts it rises rapidly to a depth of six or seven feet or even more and the current becomes much swifter. Two of my men crossed on a log one morning to dig pits on the north side of the river, but when they tried to recross an hour or two later they were unable to do so, losing their spade in the attempt. They were then obliged to walk four miles east to the railway bridge to cross it. That was all they did that day. Another day I, with three of my men, took four hours to get over. We felled tree after tree across it, but they were immediately carried off. We at last got two dry tamarack poles across and walked over on them. The river was not at its worst then. The only parts of the land liable to be flooded badly is the southeast and eastern parts. This was flooded at times about six inches deep. On the top of the hills surface water was found standing in places but was not deep. Water-power could be developed from Pine river. There are no falls, but plenty of rapids and often steep banks of considerable height. The climate was at times warm and bright and at other times cloudy, dull and very chilly. We had a good deal of rain and one or two very heavy downpours. In fact there was no lack of moisture at any time. No summer frosts were noticed, but it was very chilly at times in June. Fuel is plentiful and can be had almost anywhere in the township. Dry tamarack and spruce are the most plentiful, but there is also a good deal of poplar. No coal was found. No stone quarries or minerals were found. Bear, moose, jumping deer and rabbits were seen and a beaver dam or two were noticed. In a dry year some parts of this township might present a much better appearance, but many of the creeks were overflowing and altogether the rainfall was quite excessive when we were there.—*W. G. McFarlane, D.L.S., 1906.*

Range 25.

6. The general aspect of the country is nearly level prairie, with bluffs of poplar and willow of small size here and there. The south portion of this township is well settled up while there are only two or three ranchers living east and south of Marshy lake. The soil is of good quality with the exception of the central portion of the township, through the hills, where it is sandy. Hay is abundant in the numerous

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 25—Continued.

sloughs and marshes of this township. There are no water-powers and no mineral has been found here. There are grain elevators at every railroad station in the neighbourhood and communications with the different great centres of the West are very easy, railroads having been built in all directions through this part of Manitoba.—*J. B. Saint Cyr, D.L.S., 1906.*

24. The route for reaching this township is by trail to Mountain Gap, thence southwesterly into the mountains in section 22. This is a good road when dry but rather heavy when wet. The soil is fine black loam with clay subsoil; it is first-class farming land. The surface is gently rolling, mostly scrubby but also some prairie here and there over all the township. There is no timber of any account, except a few spruce about twelve inches in diameter, and some poplar and willow scrub. There are quite a few fairly good hay sloughs, scattered over the whole portion surveyed, but there is very little high hay meadow. The water is fresh and abundant. There are many small streams, which may dry up in summer, but one large one, Pleasant Valley creek, is about twenty-five feet wide, four feet deep and flows about four miles an hour. There is good drainage and the land is not likely to be flooded. There is a little water-power on the large creek at the rapids but no falls. The climate is cool in May, with some frosts. There was one heavy snowstorm and plenty of rain. For fuel there is plenty of dry spruce and poplar wood almost anywhere in the township. There are no stone quarries and no minerals. Game is plentiful apparently but none was seen. Plenty of moose and deer tracks were observed. These sections are well settled. There is still some first-class land unserveyed in the western part of the township, and there is only a little timber on the northwest corner.—*W. G. McFarlane, D.L.S., 1906.*

35.—The route followed is due south from Minitonas on the road allowance to the northwest corner of section 6. It was a rather bad road as it was not graded and had some very boggy holes in it. The soil on the north side of section 6 is very wet and chiefly muskeg, but to the south side of this section and also sections 5 and 4 the soil is good for farming. The surface has some timber on section 6, chiefly spruce from ten to twenty inches in diameter, with some poplar and birch of fair size. Sections 4 and 5 are chiefly scrubby with considerable windfall and broken up by deep ravines. The timber on section 6 does not extend to the south or east sides except an occasional tree. Hay is very scarce, but some could be had if the brush was cleared out of the sloughs in sections 5 and 4. Water is very plentiful and fresh. Numerous small streams are found but none with any large volume of water. The land is well drained in most places, except the muskeg to the north of section 6. There are no water-powers. The climate (in July) was mild and damp. We had considerable rain. No summer frosts were noticed. Fuel is plentiful. Wood is the only kind but there is plenty of it and it can be had almost anywhere. No stone quarries or minerals were found and no game was seen but traces of moose and deer were noticed. The timber in section 6 is in a timber limit.—*W. G. McFarlane, D.L.S., 1906.*

Range 26.

6.—All the land is taken up in this township, and a large quantity of very good wheat has been harvested this fall there. Hay is plentiful in this township. Though the soil is a little light, oats and wheat grow well. There are no early frosts to injure the crop. No mineral of any description has been found here during the progress of the work, and there is no timber and no water-power in this township. A portion of Marshy lake occupies the greatest part of sections 24 and 25; it is very deep in some places and the bottom is a black mud. This large sheet of water will only dry up

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 26—Continued.

completely when a ditch is made from the north end of the lake running in a north-easterly direction. Thousands of wild geese were seen there every day during the latter part of October and the beginning of November. This township can easily be reached from all directions. Farmers seem to be well off, every one of them having costly buildings and a good number of cattle and horses, with modern farm implements. Every well dug around here furnishes a good supply of soft water.—*J. B. Saint Cyr, D.L.S., 1906.*

35.—The route to reach this township from Pine river follows along the ridge on the old colonization road around the east side of Duck mountain. It had been many years since this road was used, and in the meantime dry logs about fifteen inches in diameter had fallen across it in great numbers, necessitating a great deal of chopping to clear it again. Besides this there were a great many soft holes, and some of the old bridges were so rotten on the top that they had to be rebuilt before we could cross them. It took us four days to make the move. The latter part of the road runs due south on the road allowance to the sawmill on section 1, township 35, range 26; thence by a very soft log road into section 2. The soil is usually very good, being a black loam with clay subsoil. Towards the west and north of the part surveyed, and also along the south side, it would make first-class farm land, although a little heavily timbered at present. Through the centre of this part there are some muskegs and swamps, but in a dry year this would likely become fairly solid, and at any rate could be comparatively easily drained into Favel river or Minitonas creek, which have a very good fall. When drained this may make good farm land too. Hay is very plentiful in sections 10, 11, 12 and some in 2 and 3. It is rather scarce towards the west side of the township, but the greater part of what is to be found is of very fair quality. The water is all fresh and very abundant especially in the easterly part. The supply is quite sufficient and permanent. Favel river and Minitonas creek are worthy of mention. Favel river is about twenty feet wide and one foot deep, and has a current of three or four miles an hour. Minitonas creek is scarcely as large. Some of the sections, such as parts of 11, 12, 1 and 2, may be flooded at times. In fact beavers are flooding some of them now about one foot in depth. No water-powers of any great value can be obtained, but Favel river might be used for a small one, as its banks are steep at the south boundary of section 1. The climate was mild and warm, but there was considerable rain. Some days were very hot. No summer frosts were experienced during July. Wood is the only fuel, but it is plentiful in all parts of the township. No stone quarries or minerals were found. No game was seen except rabbits, but moose and deer tracks were found, and also beaver dams and freshly cut trees. The timber of value is chiefly confined to sections 1, 2 and 3, and is now a timber limit. It consists chiefly of spruce from ten to twenty inches in diameter and some birch ten inches, balsam twelve inches and poplar about ten inches in diameter. Some of it is very good. There is also some timber on the westerly part which will be good for settlers.—*W. G. McFarlane, D.L.S., 1906.*

Range 27.

6.—The eastern half of this township is nearly level prairie; it is thickly settled. The country is rolling and somewhat stony and gravelly for a mile or two adjoining the west outline.—*J. B. Saint Cyr, D.L.S., 1906.*

7.—This township can be reached by the Arcola branch of the Canadian Pacific railway which runs through it from east to west. The soil is a rich black loam. Nearly the whole of the township is under cultivation, raising the best quality of wheat. The surface is rolling and void of timber or scrub of any kind except along

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 27—Continued.

Pipestone creek which flows through the northeastern part of the township. Along its banks are some large elm and poplar. Hay is rather scarce in the township, there being only a few small sloughs in which it grows. The water in Pipestone creek is fresh and of a good quality, and the supply is permanent and sufficient for all domestic purposes. The creek averages about a chain in width and three feet in depth, and has a current of about three miles an hour. The banks are high so that the surrounding country is not flooded to any extent in the spring. There are no water-powers, stone quaries or minerals in this township, The chief fuel is coal, which is brought in by the railways. The climate is about the same as the rest of Manitoba and there are no summer frosts. Reston, a village of considerable importance, is located in section 9. A large amount of business is transacted there by the settlers, who are in a very prosperous condition owing to the exceeding richness of the soil. Game, such as wild ducks and prairie chickens, is plentiful, and Pipestone creek is widely known throughout the province as a resort for wild geese.—*W. J Deans, D.L.S., 1906.*

Range 28.

5.—This township is easily reached by a road which runs south from Sinclair, a station on the Arcola branch of the Canadian Pacific railway. The surface is rolling. The soil, generally, is black loam, from eight to eighteen inches deep, with clay subsoil, and is well adapted for grain growing. There is no timber of any description, but a small amount of scrub grows around the sloughs. There is sufficient hay for the settlers' requirements in the numerous small sloughs throughout the township. The Canadian Pacific Railway company is constructing a branch line through the township, which was graded at the time of the survey, but no rails were laid. There are no stone quarries, water-powers or minerals in the township. Jackson creek, a small stream, flows through the southern part of the township. This stream is dry, except in places where there are a few pools. The water is good and free from alkali or minerals. Another small stream, which is also dry except in a few places, flows through the northeast corner of the township. The principal fuel is wood and coal, which is brought in from outside points to the nearest railway station. The climate is good and free from summer frosts. Wild ducks and prairie chickens are moderately plentiful.—*W. J. Deans, D.L.S., 1906.*

6.—This township may be reached by a good trail running south from Sinclair, a station on the Canadian Pacific railway. The surface of the township is rolling, void of timber or scrub of any description. The soil throughout is a black loam averaging from six to eight inches in depth with a clay subsoil. There are a few stony ridges in the township which, however, do not detract from the grain raising qualities of the land. Hay is plentiful in the numerous small sloughs throughout the township and is sufficient for the needs of all the settlers. A creek of fresh water flows southerly through the central portion of the township, entering on the north boundary of section 32 and leaving again on the south boundary of section 3. This stream expands in many places into pools where good fishing may be had, jackfish especially being very plentiful. The water is good and permanent, amply sufficient for all domestic purposes. Fuel consists of wood and coal, brought in from outside points by the railway. There are no water-powers, stone quarries, or minerals in the township. The climate is the same as the rest of Manitoba and free from summer frosts. The only game found is wild duck and prairie chicken, which are moderately plentiful.—*W. J. Deans, D.L.S., 1906.*

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 28—Continued.

7.—This township may be reached by the Arcola branch of the Canadian Pacific railway. The soil is generally a black loam with clay and gravel subsoil, and is suitable for wheat growing, large quantities of which are raised. The surface is rolling prairie void of timber or scrub. Sufficient hay for the need of the settlers is procured in the numerous sloughs throughout the township. There is a small stream of fresh water in the westerly part of the township which disappears beneath the surface in numerous places and reappears in pools. These pools, however, are not of a permanent nature and would probably disappear in dry seasons. There are no water-powers, stone quarries or minerals in the township. The climate is good and free from summer frosts. The settlers burn wood and coal, which is procured from outside points and brought in by the railway. Wild ducks and prairie chickens are moderately plentiful. There are quite a number of stony ridges throughout the township but the stones appear to be only on the surface and do not depreciate the value of the land for grain raising.—*W. J. Deans, D.L.S., 1906.*

8. This township may be reached by the Canadian Pacific railway, a branch of which runs from Reston to Wolseley. The soil generally is a deep black loam with clay subsoil. The township is rolling prairie void of timber or scrub, except a few elm and poplar which grow along Pipestone creek, a stream running through the northeastern part of the township. This stream averages from fifty to a hundred links in width, two to four feet in depth, with a current of about three miles an hour. The water is fresh and good and is also permanent and sufficient for all domestic purposes. The banks are high generally, so that only a small portion of the land in the valley would be flooded in the spring. There are no water-powers, stone quarries or minerals in the township. The climate is the same as the rest of Manitoba and free from summer frosts. The fuel consists of coal and wood brought in by the railway. Game, such as prairie chicken and wild duck, is moderately plentiful and geese in large numbers seek this part in the fall of the year. Bardell, a railway station and postoffice, is assuming considerable importance as a commercial centre. —*W. J. Deans, D.L.S., 1906.*

Range 29.

5. This township is easily reached by a road running south from Sinclair, a station on the Arcola branch of the Canadian Pacific railway. The surface is rolling and broken by numerous small sloughs. The soil is black loam from eight to eighteen inches deep with clay subsoil. There is no timber of any description, except along the south boundary, where there are a few bluffs of small poplar. This township is well adapted for the growing of grain, and the settlers are all engaged in grain growing. Two small streams flow southerly through the township. These streams at the time of survey were dry with the exception of occasional pools. The Canadian Pacific Railway company is constructing a branch of their road through this township. Hay is moderately plentiful in the numerous sloughs. Good water can be obtained at a depth of eight or ten feet by digging. There are no water-powers, stone quarries, or minerals of any description. The climate is good and free from summer frosts. The settlers are largely dependent on the railways for their supply of fuel, which is brought from outside points. Wild ducks and prairie chickens are moderately plentiful.—*W. J. Deans, D.L.S., 1906.*

6. This township may be reached by a trail which runs south from Sinclair, a station on the Canadian Pacific railway. The township is rolling prairie destitute of scrub or timber of any description. The soil generally is a black loam averaging in depth from six to eighteen inches with a clay subsoil. There are a few ridges which are inclined to be stony, but apparently these do not detract from the producing qualities of the soil, as I saw excellent wheat growing on land which was quite stony

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 29—Continued.

in places. There is sufficient hay for the settlers' requirements in the numerous small sloughs throughout the township. Jackson creek flows southerly through the centre of the township and Graham creek flows through the southwest corner. These creeks in dry seasons have no current, but consist of numerous apparently disconnected pools; the water is fresh and good and in sufficient quantities for the settlers' requirements. The principal fuel is wood and coal, which is brought in by the railway from outside points. There are no water-powers, stone quarries, or minerals in the township. The climate is the same as the rest of Manitoba, and free from summer frosts. Wild duck and prairie chicken are moderately plentiful.—*W. J. Deans, D.L.S., 1906.*

7. This township may be reached by the Arcola branch of the Canadian Pacific railway, which runs through it from east to west. The surface is rolling and broken by a number of small sloughs and stony ridges, particularly in the westerly part. The easterly part of the township is much better, and largely under cultivation, growing wheat of the best quality. A small stream runs through the township, which disappears beneath the surface in many places and reappears again in pools. The water in these pools is fresh and good, but in a very dry season would probably disappear. The settlers are principally engaged in grain growing, there not being sufficient hay to engage largely in dairying or cattle-raising. There is no wood in the township, but a few scattered clumps of willow grow around the sloughs. There are no stone quarries, water-powers or minerals. Good water may be obtained by digging to a depth of from ten to twelve feet. There are no summer frosts. Early vegetables do well and attain great perfection. Game, such as wild duck and prairie chicken, is moderately plentiful. Sinclair, a village of about one hundred inhabitants, is located on section 13. It has an elevator, three stores and a few other business places. Fuel and lumber for building purposes are brought in by the railway from outside points.—*W. J Deans, D.L.S., 1906.*

8. This township is easily reached by a road which runs north from Sinclair, a station on the Arcola branch of the Canadian Pacific railway. The surface is rolling and greatly broken by small sloughs and hay marshes. The soil is black loam from four to eighteen inches in depth with clay and gravel subsoil. There is no timber or scrub of any description. The settlers are principally engaged in growing wheat, of which they produce large quantities of the best quality. The Canadian Pacific railway has recently constructed a line from Reston to Wolseley which runs through the northeast corner of this township. Sufficient hay is found in the numerous sloughs for all requirements of the settlers. A small stream flows through the easterly part of the township, in a southerly direction, this stream at the time of survey was dry, except for a few pools which contained good fresh water. In a dry season these pools probably would disappear; but good water can be obtained in unlimited quantities at a depth of eight or ten feet. The settlers are largely dependent on the railway for their supply of fuel, which is brought in from outside points. There are no water-powers, stone quarries, or minerals of any description. The climate is the same as the rest of Manitoba and free from summer frosts. Game, such as wild duck and prairie chicken, is moderately plentiful.—*W J. Deans, D.L.S., 1906.*

9. This township is, for the most part, open rolling prairie. The portion, sections 24, 25, 26, 34 and 35, through which Pipestone creek passes, is much more broken and is also dotted with bluffs of poplar and willow. Numerous sloughs occur all over the township, many of which were dry at the time of survey. The soil is generally a black loam of from eight to fourteen inches in depth, with a clay subsoil, though some of the sections in the western portion are quite stony. The crops were good, both wheat and oats apparently doing well on the cultivated portion. The Wolseley

TOWNSHIPS WEST OF THE PRINCIPAL MERIDIAN.

Range 29—Continued..

branch of the Canadian Pacific railway crosses the township diagonally from southeast to northwest and will be in operation this fall. The townsite of Ebor, in section 15, has been laid out and several buildings are in course of construction there, among others a large grain elevator. Both the Canadian Northern railway and the Grand Trunk Pacific railway have made surveys for railways westerly to Regina through the township, but the lines are not yet finally located. Pipestone creek averages in width about one chain, about two feet in depth, with a current of about three miles an hour; the banks are high and the valley quite narrow, so that only a small portion would be inundated by the floods in the spring of the year. The water is fresh and of good quality, permanent and sufficient for all needs of the settlers. There are no stone quarries, water-powers or minerals of any kind in the township. Fuel is scarce and the settlers depend on the railway companies to bring them in wood and coal from outside points. The climate is the same as the rest of Manitoba and free from summer frosts. Prairie chicken and wild duck are numerous, and jackfish abound in Pipestone creek. Fruit, such as wild plums, saskatoon berries, raspberries and cranberries, is very plentiful. Hay is found in suficient quantities throughout the township for the requirements of the settlers.—*W. J. Deans, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 1.

52. *North outline.*—The westerly third of this township is very rough and broken, being in the Pasquia hills. This part consists of hills and valleys, the hills being two hundred to three hundred feet above the valleys and the whole many hundreds of feet above Carrot river, which flows easterly some six miles to the north of this township. Mountain creek flows in a valley three hundred feet deep and crosses close to the northwest corner of the township. The timber is nearly all birch with poplar and spruce in less quantity. The middle third is rolling and falls rapidly to the east. The easterly third is undulating and swampy with a thick growth of spruce and tamarack. Besides Mountain creek the only other stream of any size crossing the north outline is a branch flowing northeast across section 34 to Waskwei river. The timber in this township is not generally more than ten inches in diameter.—*J. N. Wallace, D.L.S , 1906.*

53. *East outline.*—The southwesterly part of the township is in the Pasquia hills, is very rough and broken and is thickly timbred with birch, poplar and spruce. The remainder of the township is flat and swampy and near the northeast corner is all bogland or tamarack swamp.—*J. N. Wallace, D.L.S., 1906.*

54. *East outline.*—Carrot river flows northerly close to the east outline through sections 1, 12 and 13, crossing the outline three times. Along its banks the lands are heavily timbered with cottonwood and poplar with a few spruce, but back from the river there are extensive open flooded areas. Section 24 is thickly timbered with spruce eight to ten inches in diameter. Section 25 is open, wet slough land, and section 36 is also very wet with willow bushes and small tamarack.—*J. N. Wallace, D.L.S., 1906.*

55. *East outline.*—Along the east of sections 1, 12 and 13 the land is level and wet, being composed generally of tamarack bogs, although the north half of section 12 and the south half of section 13 may prove good land if drainage can ever be carried out. The north half of section 24 and all of sections 25 and 36 are generally thickly timbered with ten-inch spruce and poplar, and willow trees. A remarkable old river channel about one hundred feet wide coming up from the southwest crosses

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 1—Continued.

sections 25 and 36. It is now full of dead water, but apparently it was at one time the channel of some river. There are many such old channels in the district, to which the Indians apply the generic term 'Petabek.'—*J. N. Wallace, D.L.S., 1906.*

56. *East outline.*—Sections 1 and 12 are composed of level lands with a dense tangled growth of tall willow with bluffs of poplar. Sections 13 and 24 are generally open slough land with willow, and the south half of section 25 is thickly timbered with poplar and willow along the south bank of Saskatchewan river. Birch river crosses about the centre of section 12, and the winter mail route from Cumberland House to The Pas mission crosses the east of section 24.—*J. N. Wallace, D.L.S., 1906.*

Range 2.

52. *North outline.*—The whole of this township is in Pasquia hills. It is all rough broken country. The hills are two hundred to three hundred feet above the valleys and the whole area is from nine hundred to fourteen hundred feet above Carrot river, which flows easterly some six miles to the north of this township. The timber is dense and consists of birch, poplar and a few spruce. Fully three-quarters of the timber is birch. The township is altogether too rough for settlement. There is probably no grass in these hills.—*J. N. Wallace, D.L.S., 1906.*

Range 3.

44. *Section 28.*—The route to this section is along the Prince Albert branch of the Canadian Northern railway to Etoimami, a small station on this line, thence south along a 'tote' road used by lumber camps in the vicinity. Said road crosses the 12th base line about one and one-half miles south of the railroad at this point. The soil is generally very sandy and of poor quality, with a substratum of alluvial gravel. There are patches of good black mud in the swampy parts, but these would have to be drained. The surface is wholly covered with scrub, poplar and spruce, and is generally undulating and facile for roads. The greater part of the section is covered with small scrub pine. The spruce is small and of little value. The timber on the east half of the section is mostly small scrub pine. The southwest quarter is a willow swamp with patches of poplar. Along the banks of Red Deer, Etoimami, and Fir rivers are dense willow with poplar and a few spruce and birch. There is no hay. The water of the three rivers mentioned is fresh and of excellent quality, and the supply appears to be permanent. Red Deer river is about six feet deep and two hundred and fifty feet wide, with a fairly swift current, and the Etoimami is two hundred feet wide and about the same depth. Fir river is one hundred feet wide and about four feet deep. The volume of water will vary according to the season, and in the Fir may dwindle down to a mere stream. There is little possibility of floods as the banks are high. There are no falls, but water-power could be developed by damming. The general indications are that the summers are hot, with probably early fall frosts. The winters are bearable, as good shelter is afforded by timber. There are no indications of coal deposits. Settlers must rely upon the timber for fuel, which for this purpose is fairly plentiful. There are no stone quarries, but there is alluvial gravel throughout the section. No minerals occur. The game consists of rabbits and partridge, with a few ducks and geese.—*R. J. Jephson, D.L.S., 1906.*

52. *North outline.*—The northwest quarter of this township is hilly, being on the lower slopes of the Pasquia hills. The remainder is in the hills, and is very rough and broken, being composed entirely of hills and valleys. The whole is thickly timbered with birch, spruce and poplar, and is too rough for settlement. It is probable that there is absolutely no grass in these hills.—*J. N. Wallace, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 4.

52. *North outline.*—Carrot river flows north across the middle of section 34. The part of the outline west of this river is entirely across sloughland, all more or less flooded. The land is quite useless until some system of drainage on a large scale lets the water off the surface into either Carrot river or Sipanok channel, when the soil would probably be found to be very good. Such a scheme is undoubtedly feasible at some future time when this district becomes more settled. The east half of the outline is in a timbered district. The land is here marshy, and irregularly covered with patches of spruce, poplar, willow and tamarack. A large stream, called Rice river, flows westerly along the eastern portion of the outline, coming from Pasquia hills and flowing to Carrot river. It is reported to have a high waterfall some miles to the southeast.—*J. N. Wallace, D.L.S., 1906.*

Range 5.

52. *North outline.*—The line runs through an area of continuous sloughland, all more or less under water, and is quite unfit for cultivation until drained on a large scale into Carrot river, which should be a feasible operation when the progress of settlement justifies a large outlay. Carrot river is considerably lower than the standing water in the sloughland and would afford a good basis for a system of drainage. There is also Sipanok channel to the north which could be similarly utilized. The land is not swampland, or bog, but pure sloughland. Indian reserve No. 28A and the Shoal lake branch of Pas Mt. Hudson bay post, are in this township. All kinds of garden produce grow very well here. There is no summer frost.—*J. N. Wallace, D.L.S., 1906.*

Range 6.

52.—*North outline.*—The line runs entirely through an area of sloughland. Slough grass and reeds are the only vegetation, with a willow bush here and there. There is, however, a very marked belt of timber along the banks of Carrot river. This belt, about one hundred yards wide on each side, consists of comparatively dry land about fifteen feet above the level of the water in the river. It is probably to be accounted for by floods in years gone by having cast up and deposited the soil carried down by the water. The timber belt forms a very marked feature of the landscape, and serves to identify the position of the river when seen miles away. The greater part of Indian reserve No. 29A, and the Hudson bay post called Pas Mountain or Red Earth are in this township.—*J. N. Wallace, D.L.S., 1906.*

Range 7.

52. *North outline.*—Except a small poplar ridge at the east end of section 31, the whole of the lands along the north outline are more or less under water. Section 31 consists almost wholly of a very bad bog. The remaining five sections are sloughland. There is practically no vegetation over this sloughland, except long slough grass and reeds. The district is a vast slough, and is worthless until some system of drainage on a very large scale is carried out, when the soil will likely prove to be good. The easterly part of Indian reserve No. 29A is in this township. Carrot river would supply a feasible basis for drainage as it is below the level of the standing water on these lands.—*J. N. Wallace, D.L.S., 1906.*

Range 8.

52. *North outline.*—Except section 36, the whole of this north outline is across an uninterrupted series of flooded bogs, swamps and muskegs extending in all directions. There is no drainage apparent, not a single creek being crossed on the whole

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 8—Continued.

six miles of the outline. The surface is all moss-covered. Section 36 is covered with eight-inch poplar and spruce on a local ridge and is dry land.—*J. N. Wallace, D.L.S., 1906.*

Range 9.

7.—This township may be reached by a good trail from Stoughton on the Arcola branch of the Canadian Pacific railway. The soil is a black loam with clay subsoil and is well adapted for wheat growing; farmers engaged in that business raise large crops of excellent quality. The surface is rolling prairie, void of scrub or timber of any kind. There are a number of sloughs scattered throughout the township in which a considerable amount of hay is cut. In the southern part of the township there is a stream; but at the time I was there it was dry except for pools in places. The water was fresh and free from alkali. The climate is free from summer frosts. Wood for fuel or building can be obtained on Moose mountains at a distance of twenty-five miles north, and lignite is mined twenty-five miles to the south. There are no stone quarries, minerals or water-powers in the township. Game such as wild duck and prairie chicken is plentiful.—*W. J. Deans, D.L.S., 1906.*

52. *North outline.*—Section 31 is fair land, is dry and is covered with a mixed growth of large poplar and spruce. Section 32 is swampy and moss covered, with small spruce and tamarack. The easterly four miles cross an uninterrupted area of flooded bogs, muskegs and swamps extending many miles to the north and south.—*J. N. Wallace, D.L.S., 1906.*

Range 10.

52. *North outline.*—The westerly four miles are first-class land, sections 31 and 32 being covered with eight-inch poplar and sections 33 and 34 with willow trees. Except for a small poplar ridge near the northeast corner of the township, sections 35 and 36 are swamp land, covered with spruce and tamarack, but south of these sections the land improves somewhat.—*J N. Wallace, D.L.S., 1906.*

Range 11.

52. *North outline.*—Section 31 is generally dry and rolling and is covered with light poplar. Section 32 is lower land and there is a good deal of marsh covered with willow, but there is no swamp land. Sections 33 and 34 and the west half of 35 are pure bog. Very extensive swamps stretch to the north and south. The east half of section 35 and all of section 36 is first class land with a thick growth of poplar or tall willow trees. Petaigan river flows north to the Saskatchewan across section 35. The winter mail route from Fort à la Corne to Cumberland House crosses the bogland in section 34.—*J. N. Wallace, D.L.S., 1906.*

Range 12.

52.—*North outline.*—Saskatchewan river flows for five miles almost along the north outline. All the north sections, except 36, are much broken by the river and by its channel around Birch island which last contains two or three square miles. The timber along the river is very heavy, consisting of spruce up to thirty inches and cottonwood up to four feet in diameter, but it does not extend far back from the river. The Saskatchewan varies in width near the north outline from over eight hundred yards to only two hundred and seventy-five yards. The shores are soft and muddy. The outer banks are one hundred to one hundred and seventy-five feet high. The only unbroken section along the north is section 36, which contains some good land on its east half.—*J. N. Wallace, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 13.

52.—*North outline.*—Sections 31 and 32 are the best land along the north. The remainder of the outline passes through an undulating country generally lightly timbered with willow marshes and bluffs of poplar or jackpine. The soil becomes very sandy near Saskatchewan river. The northeast corner of the township is on an island in the river. There is very little swamp land.—*J. N. Wallace, D.L.S. 1906.*

Range 14.

52. *North outline.*—Sections 31 and 32 are very sandy and are much broken by the valley of Torch river. Section 33 is better land but is a good deal broken by the same river. Section 34 is good land and is nearly open country. South of this section there is much open burnt country, with a few small poplar. Section 35 is very swampy with a wet mossy surface. Section 36 is good with a light mixed growth of willow and poplar and patches of spruce.—*J. N. Wallace, D.L.S., 1906.*

Range 15.

52. *North outline.*—The area of large timber which extends across the easterly half of range 16 ends about the middle of section 31 in this range. The outline generally runs through a rolling, partly open country, consisting of very sandy elevations covered by a few small jackpine, alternating with lower lands with small poplar and willow. Across section 36 the soil is pure sand, and is almost barren, although there is a light growth of small jackpine. Torch river, a stream one hundred and ten feet wide with a swift current and a gravel bed, rises in Candle lake and flows southerly close to the township corner. It, however, turns back and ultimately flows northeast. The central part is the best of the northerly portion of the township.—*J. N. Wallace, D.L.S., 1906.*

Range 16.

52. *North outline.*—Section 31 is swamp land with small spruce and tamarack. The west half of section 32 has a large hay meadow in which Fern creek rises, a stream which flows easterly and then southeasterly. There is heavy spruce timber on sections 33, 34, 35 and 36 especially on the west half of 36 where it runs to thirty inches in diameter. There is much fallen timber on section 34. The soil is generally second and third class across this range. A pack trail from Whitefox river to Torch river crosses section 35.—*J. N. Wallace, D.L.S., 1906.*

Range 17.

52. *North outline.*—The westerly four miles are generally covered with poplar and willow, with local tamarack swamps. Section 36 is all swamp land with a thick growth of small spruce. There is heavy poplar and spruce timber along the west of Kelsey creek, a stream which flows south to Whitefox river, through sections 35 and 36. The westerly part of this range is the best.—*J. N. Wallace, D.L.S., 1906.*

Range 18.

52. *North outline.*—The westerly three and one-half miles are covered with willow or bluffs of large poplar, and the soil is generally good. There are many willow marshes but no bogs or swamps. The remaining two and one-half miles to the east corner are very swampy, and there are extensive bogs. Only one small creek, four feet wide, flowing southeast, crosses the whole six miles. A pack trail from Whitefox river to Torch river crosses section 36.—*J. N. Wallace, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 19.

14. In this township I found that the lake shown on sections 3, 4, 8 and 9 is entirely dried up, and that the whole area is now a very excellent hay marsh on which hay in great quantities is being cut. The lake shown on sections 10, 11, 14 and 15 is all dried up except a pond on parts of sections 10 and 15, the area of which is about 55 acres. The balance is entirely dried up, and parts on sections 11 and 14 is also an excellent hay marsh. The eastern parts of sections 10 and 15 are covered with rank weeds. I produced the lines of the adjoining section through the lakes and dug pits in order to mark the true corners, connecting the pits on each side of the lakes by straight lines. The whole area, with the exception of the pond, would be quite available for hay land. The parts of the land in sections 10, 11, 14 and 15 could be quite easily drained by cutting a drain or ditch along the side road into the pond, which would help to keep up the supply in the pond. This pond is of great value as it is the only water that can be had for a great distance except in wells.—*James Warren, D.L.S., 1906.*

52. *North outline.*—The whole of the north outline is through coniferous timber. The lower lands are bogs and swamps; the remainder is sandy elevations covered with jackpine. Only one small creek, two feet wide and flowing southeast, crosses the whole six miles, so that the lands have no drainage. The rainfall runs into the depressions and remains there till evaporated, forming bogs and swamps. About sixty per cent is under water, more or less deep. The entire surface is moss covered. The east half of section 36 is the only poplar area, and is dry.—*J. N. Wallace, D.L.S., 1906.*

Range 20.

52. *North outline.*—The westerly four miles crosses a district entirely covered with coniferous timber, with the usual accompaniment of a mossy surface. The lower lands are tamarack bogs and spruce swamps; the rest (a few feet higher) are bluffs of small jackpine. There is a remarkably sudden change of timber in section 35, where poplar and leaf loam take the place of the coniferous trees and moss. The poplar here run to twenty inches in diameter, with much undergrowth of alders and cranberry. Only one small creek crosses the whole six miles. There is practically no slope for drainage. A pack trail (a very good one) from LaCorne to Torch river crosses section 35.—*J. N. Wallace, D.L.S., 1906.*

Range 21.

52. *North outline.*—The northwest corner of this township and the west half of section 31 come in Birchbark lake. The east half of section 31 and the west half of 32 are heavily timbered and hilly. The remainder of the outline to the northeast corner traverses some extensive swamps, the higher lands being sandy elevations with small jackpine. The surface is practically all moss covered. There are a few partially open dry areas, but they are covered with dead small timber and the soil is almost barren. Along the north outline it is a very poor district. Only one creek about six inches wide crosses the whole six miles.—*J. N. Wallace, D.L.S., 1906.*

Range 22.

50. This township lies about twenty-five miles by trail in an easterly direction from Prince Albert. It can be reached by following the Fort à la Corne trail to township 49, range 22, from there taking a branch line crossing Saskatchewan river, and entering this township in section 6. The condition of this trail is good. This township can also be reached by following the Candle lake trail to township 51, range 23 and from there taking a branch trail running in an easterly direction to section 31

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 22—Continued.

of this township. This trail is in poor condition. The western half of this township consists of a black or black sandy loam about sixteen inches deep with a sand subsoil. It should be excellent soil for mixed farming. The eastern half is composed entirely of sand. The surface is of a varied nature. From the southwest corner, extending in a northeasterly direction, is a large patch of prairie covered with scrubby poplar and willow. To the north of this, the land is more heavily timbered with poplar from two to eight inches in diameter and some willow. The eastern half is covered with jackpine, spruce and birch, interspersed with willow and jackpine scrub. The timber consists of jackpine and poplar. On sections 1, 4, 9, 10, 12, 15, 23, 24 and 25, jackpine will be found large enough for tie purposes. It averages from two to sixteen inches. The poplar is too small for building purposes. Small hay sloughs are found all over the township. On the north, from a large muskeg extending across the township, large quantities of hay of a second quality can be obtained. Water is of good quality, wherever found. The eastern half is poorly supplied with water. A large muskeg is found on the north of the township. A creek with excellent water, and which runs the entire year enters on section 7 and leaves on the south of section 5. It has steep banks about fifty-two feet high where it leaves the township. There is no water-power. The climate is mild, the first frost being noticed on August 22, while open water was frozen on November 15. Fuel in the form of dead wood is obtainable in any part of the township. No coal, stone or mineral was noticed. Prairie chickens were very numerous.—*R. H. Montgomery, D.L.S., 1906.*

50. The northwest part of this township is broken by muskeg, sand ridges and hay sloughs. It is timbered with scrub poplar and willow on the sides of the ridges and large scattered jackpine on the tops. There are several strips of tamarack swamps along the margins of the muskegs. In the southwest corner of the township the land rises to an elevation of about eighty feet above the level of Sackatchewan river. Section 6, west half of section 5, and south halves of sections 7 and 8 are high and undulating. The soil is a heavy clay loam, the subsoil being a sandy clay. There is no timber of any account on these sections, except a spruce bluff on the northeast corner of the northwest quarter of section 6, of about twenty-five acres in extent, suitable for building purposes. There is a small creek coming from a muskeg in the northwest part of the township, probably a continuation of the creek crossing through township 50, range 23. It runs in a southeasterly direction through sections 20, 16 and 5, and flows into Saskatchewan river. The northeast part of the township is level and rising gently towards the east. It is timbered with a dense growth of poplar and balm of Gilead, two to five inches in diameter. The soil is a black sandy loam with a deep deposit of vegetable mould; the subsoil is a sandy loam. The southeast part is high and undulating. Sections 1, 12 and 14 are timbered with jackpine and interspersed with poplar. Sections 2, 3, 11 and 10 are covered with a dense growth of young jackpine, there being an occasional small bluff of large jackpine, which escaped the fires that burned over this area in 1886. There is much half burned and decayed pine timber scattered over the above sections. Sections 4, 9 and the east half of 5 are covered with muskeg. This soil is for the greater part pure sand. I am of the opinion that this township should be surveyed as there is a considerable quantity of good land in the northeast part. The southeast part, being near good timber, would induce many settlers to take the land that is not highly esteemed.

GENERAL.

The six townships which I have reported, viz. : townships 51, ranges 22, 23, 24 and 25, and townships 50 ranges 22 and 23, wes of the second meridian, lie in one of the choicest and most extensive valleys in Saskatchewan, being from twelve to

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

GENERAL—*Continued.*

twenty miles wide and extending east between Candle lake and Saskatchewan river to the outlet of Torch river into Saskatchewan river in township 57, range 4, west of the second meridian. Whitefox river flows through the centre of the valley from township 51, range 23, and enters Torch river twenty miles east of Candle lake. Torch river, with its increased volume, is fifty feet wide, one and a half to three feet deep, and has a stony bed; the current is also greater and is from four to six miles per hour. There are good facilities for making use of the water-power on this stream. The valley is bounded on the west by a chain of sandy hills extending north from Saskatchewan river to the second tier of sections, running east and west in township 50, range 25, and by Little Red river in township 51, range 26. On the south it is bounded by a chain of sand ridges extending from township 49, range 23, to Nipawin point, along the north side of Saskatchewan river and north from four to two miles. These hills are timbered with poplar, spruce and jackpine; on the north side it is bounded by a chain of ridges that extend from Little Bittern lake near the south boundary of township 54, range 26, then in a southeasterly direction to near the northeast boundary of township 51, range 23, and in a northeasterly direction towards Little Candle lake. There is a considerable area of good agricultural land in the broken country north of township 51, ranges 23, 24 and 25, and I am impressed that large and prosperous settlements could be established there. There are several very fine lakes which contain pickerel, pike and mullet. Moose, elk and red deer are very plentiful. There are rich deposits of marl, suitable for the manufacture of cement, distributed over the country, north and east of Little Red river and with abundance of timber, clay and water-power, there are few places where cement could be produced as cheaply. There are very heavy belts of spruce timber surrounding Birchbark, Loon and Candle lakes, which are situated in the midst of the broken area. The portions that are most densely timbered have been taken up as timber berths. These I have been informed will be operated next year, affording employment for several hundred men during the winter and sawing seasons. A branch of the valley forks off and crosses Saskatchewan river between Lobins rapid and Torch river portage, and extends in a southeasterly direction until it merges into the delta of the Saskatchewan. Sipanok channel flows from Saskatchewan river through the valley and enters Carrot river in township 53, range 2. The valley is timbered on the east side of the channel with spruce, poplar and very large birch, extending back for a distance of from three to eight miles. There is a long open space on the west side of Sipanok channel in which there is room for a large settlement. The soil is very suitable for agricultural purposes. There are narrow strips of timber at intervals, which are suitable for building purposes.—*A. L. Robertson, Forest-ranger, 1906.*

51. The topography of this township is level, with long gentle undulations, suitable for drainage. It is more densely timbered than township 51, range 23, with poplar, balm of Gilead and willow along the margins of the hay meadows. There are a few small bluffs of spruce along Whitefox river. There are long, narrow reaches of openings on the west half of the township. The east half is covered with small poplar, and a few small hay meadows in the southeast part. The soil is a rich black loam, the subsoil alternating from sandy loam to a heavy clay. Whitefox river enters the township on section 19, and a tributary stream enters on section 30. The tributary joins Whitefox river on the northwest quarter of section 20. It then flows in a southeasterly direction, passing diagonally through sections 21, 15, 13 and 12, and crossing the east boundary of the township about twenty rods north of the northeast corner of section 1. The land in this township is excellent, and where timbered would be easily cleared as the timber is small. It is well adapted for mixed farming. There are no permanent sloughs in the township.—*A. L. Robertson, Forest-ranger, 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 22—Continued.

52. *North outline.*—Sections 31 and 32 are the best. These have a general growth of poplar mixed with a few spruce, and there are many willow sloughs. The remaining sections are either swampy, with tamarack or spruce, or consist of bluffs of jackpine, and are practically all moss covered, except a narrow belt of poplar land close to the west shore of Birchbark lake. The northeast corner of the township comes in the middle of Birchbark lake. This lake is some seven miles long, north and south, and is about one and one-half to two miles wide. It empties northerly by a small stream flowing into Candle lake, which is reported to be about fifteen miles north of Birchbark lake. There are extensive swamp areas to the southwest of this lake, and some very fine timber around its southern extremity.—*J. N. Wallace, D.L.S., 1906.*

Range 23.

50. The southeastern part of this township is high land, broken by hills and ridges which are sparsely timbered with coarse cull jackpine and large scraggy poplar. The soil on the tops of the hills is sandy and on the sides is sandy clay. Some of the valleys are densely timbered with small poplar and balm of Gilead two to five inches in diameter. In other valleys there are long reaches of good hay meadows with dry, hard and even surfaces. The soil in the valleys is black sandy loam, with a sandy subsoil. The northeastern portion of the township is broken by sand ridges running east from sections 22 and 27, crossing the east boundary of the township into township 50, range 22. The hills are timbered with rough jackpine and scrub poplar. In the valleys there are hay meadows, muskegs and willow. The west half of the township is situated in a valley which runs to the outlet of Torch river. It is timbered with poplar, from two to five inches in diamter. There are open spaces here and there, which were burned over, also hay meadows. This part of the township is undulating and sloping towards the northeast. There is a small creek which flows from a muskeg in township 49, range 23, crosses the south boundary of the township on section 4 and runs in a northeasterly direction and is lost in the muskegs in the northeast part of the township. This west half of the township is well drained and dry. There are several small bluffs of spruce along the banks of the creek, suitable for building purposes. There is a good trail leading into this part of the township, which crosses section 32 from the Candle lake trail. The west half of the township is well adapted for mixed farming. The soil is a black sandy loam, with a sandy clay subsoil.—*A. L. Robertson, Forest-ranger, 1906.*

51. This township lies in a valley and is timbered with poplar and balm of Gilead, two to ten inches in diameter. Not more than ten per cent of this timber will go over six inches. There are small bluffs of spruce, suitable for building purposes, varying from one to five acres in extent scattered over the township. The township is honeycombed with openings, some being stretches of hay meadow with dry smooth surfaces. Other openings were caused by forest fires and are from ten to two hundred acres in extent, on which willow, hazel and scrub poplar are growing, interspersed with hay, peavine and vetches. The township is drained by Whitefox river, which is ten feet wide and twelve inches deep, with a current of two to three miles per hour. The river has a stony bed. The water is clear and free from alkali. The river enters the township at section 22, passing through a muskeg on this section and continuing through sections 29 and 21, then running in a southeasterly direction to the south boundary of section 23, then in a northeasterly direction through section 24, crossing the west boundary of the township on the southwest quarter of section 24. Another creek enters this township, on section 34. It is ten feet wide, twelve to eighteen inches deep, with a current of two to three miles per hour, and having good clear water and a stony bed. It flows south through the east half of section

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 23—Continued.

34, through section 26, then southeast to the centre of section 25, passing out of the township about twenty rods south of the northeast corner of section 25. The Candle lake trail enters the township on section 7, and continues in a northeasterly direction through sections 18 and 17 to the centre of section 20, then north through sections 20 and 32, crossing the north boundary of the township about thirty rods east of the northeast corner of section 31, leading from section 29 in an easterly direction to section 24. The soil is a deep black sandy loam with a subsoil alternating from sandy clay to heavy clay. This township is suitable for mixed farming.—*A. L. Robertson, Forest-ranger, 1906.*

51. This township lies some twenty-five miles northeast from Prince Albert. Candle lake trail passes through it, entering on the west boundary of section 7 and leaving on the north boundary of 32. This trail is very heavy and rough and the opening up of a good road is one of the first requisites of this township. The soil is composed of black loam sixteen inches deep with clay subsoil. There are occasional sand ridges towards the south of this township. The surface is covered with poplar from four to six inches in diameter and willow and large hay sloughs. This land will readily adapt itself to farming of a mixed character. On sections 25, 26, 32 and 33 scattered spruce, averaging from eight to twenty inches in diameter and on sections 9, 10, 11, 14, 15, 26 and 27, poplar eight to sixteen inches will be found. This timber should be reserved for building purposes. Large hay sloughs of good quality will be found all over the township. The water is all fresh. Beaver creek passes across the northeast corner of the township, entering on the north of section 34 and leaving on the east of section 25. Several creeks are tributaries to it. On the whole a good natural system of drainage is worked out. Beaver creek in this township is ten feet wide and one foot deep, becoming stagnant in dry seasons. Apparently in wet seasons this township has been entirely flooded. There is no water-power. The climate is mild, the first frost being observed on August 25 and the first snowfall on November 5. There is plenty of dead wood for fuel. No coal or minerals were found. Stone was found along the creek beds. Partridge, deer and moose were very plentiful. There are timber berths northeast of this township and when these are developed the settlers of this township will receive a ready market for their produce.—*R. H. Montgomery, D.L.S., 1906.*

52. *North outline.*—Sections 31 and 32 are partly covered with poplar, some of which is eight inches in diameter, and partly with willow sloughs. The soil is generally good. A well known open area called 'Whitefox plains' occurs in section 32. The road from Prince Albert to Candle lake traverses this open area, and crosses the north outline of the same section. Section 33 is marshy, with willow sloughs and some bluffs of heavy spruce. Section 34 is high land and appears to be a good section. Sections 35 and 36 are covered with small spruce and jackpine and are swampy. —*J. N. Wallace, D.L.S., 1906.*

Range 24.

50. This township can be reached by Candle lake trail, which enters it on the west boundary of section 19, and leaves it on the north boundary of section 33, being some nineteen miles northeast from Prince Albert. It can also be reached on the south by a trail which I made, leaving the Candle lake trail at the southwest corner of township 50, range 25, running due east, entering the township at the northwest corner of section 6, being some fifteen miles from town. The condition of both trails is poor. The soil is a very heavy rich black loam. The township is entirely covered by bush and scrub, consisting of poplar, spruce, tamarack and jackpine, with poplar scrub and willow. There are numerous small groves of spruce, good timber averag-

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 24—Continued.

ing from four to thirty inches all over the township. A large portion has already been cut for ties. In the northeast corner of the township there are immense hay sloughs, the hay being of a second class quality. On the whole the land is very low, and generally speaking under water, with the exception of that immediately adjoining Garden river, which enters the township on the west boundary of section 19, flowing southeast and leaving on the east boundary of section 1. It has good water and is about forty feet wide, four feet deep and running about two miles per hour. As the river is some ten feet below the general level of the country, most of the land can be drained by a slight amount of local improvements, such as the building of ditches. This would leave immense hay meadows of first-class soil. There are no water-powers. The climate is mild, there being considerable rainfall during June and July. There is abundance of fuel, but no mineral or stone of any description. Numerous duck, deer and moose are to be found in the township.—*R. H. Montgomery, D.L.S., 1906.*

51. This township lies in the valley, is level, and well drained by two creeks, which enter the township on the north boundary, one on section 33 and the other on section 35. They flow in a southerly direction and come together on section 15, continuing south through the fifty-mile muskeg which enters the township at section 35, then passing through sections 35, 26 and part of the west half of 14, 10 and 3. The muskeg varies from a half to one mile in width. In some places it is covered with a dense growth of willow, and can be crossed in safety with a loaded wagon at any season. At other points it is a quaking bog and unsafe to cross except in winter. The land on the east side of the muskeg is a deep rich black soil, with a sandy loam subsoil. It is timbered with poplar, balm of Gilead, a few scattered spruce and willow along the margin of the muskeg. The openings in this part are hay meadows with dry smooth surface, extending back from the edge of the muskeg, which lies lower than the land on either side, and appears to have been the bed of a very large stream or lake which had been filled up. There are no permanent sloughs in this township. In going over this township I crossed a number of dry water-courses, leading into the creeks and muskegs and from hay meadows, which accounts for the good condition of the meadow surfaces. The land west of the muskeg is level, and had been thickly timbered at one time with poplar and balm of Gilead. Forest fires burned over the area many years ago, leaving long narrow strips of timber extending from east to west, this giving the country a park-like appearance. In the open spaces willow, hazel and good hay are growing. The soil is a deep black sandy loam, except a small area in section 22 near the muskeg, and that is light sandy loam with a sandy subsoil, and a few scattered jackpine growing here and there.—*A. L. Robertson, Forest-ranger, 1906.*

52. *North outline.*—The surface is generally undulating, and the timber almost all black and white poplar, although there are a few isolated bluffs of heavy spruce, especially in the southerly parts of sections 35 and 36. There is not much open country, but quite a number of willow sloughs exist which always contain good soil. A few small creeks cross the north outline. The largest poplar, averaging ten to twelve inches, occurs in section 31.—*J. N. Wallace, D.L.S., 1906.*

Range 25.

5. This township is divided into three sections by Willowbunch lake, which extends nearly across the township from east to west, and which breaks up the township a good deal. This township is not easy of access as it is away from any of the leading trails except local trails. There is a good deal of hard soil in parts. Quite a number of

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 25—Continued.

sections are very good and would be adapted for grain-growing. The surface is entirely open, undulating prairie without any timber or scrub of any kind, and there are no hay lands or marshes. This will render it difficult for any settler to obtain any quantity of hay. There is very little water to be obtained in any part of the township—as the water in the lake is not suitable for use, being quite alkaline. There are a few ponds of good water in the northerly part of the township. There are no streams and consequently no mill sites. The climate indications are favourable and there are no indications of any summer frosts. Fuel is scarce, there being no timber of any size on any part of the township. Nor are there any indications of coal or lignite, and there are no stone quarries nor fixed rock of any kind. Game is scarce, almost unknown, owing to the want of shelter and water. Parts of the township would be available for settlement and ranching as there is in some places nice pasturage and grass in some of the low lands. On the whole the northern portion is better adapted for grain-growing.—*James Warren, D.L.S., 1905.*

11. The best way to reach this township is by a trail from Moosejaw. This trail is a very good one and easy to travel on as there are no bad hills or ravines on the route. The soil is generally clay, in some places very hard and gravelly. From the nature of the soil it would not be adapted to agriculture or farming, but would be more suitable for ranching as there are many ponds of good water distributed over the township and the pasturage is fairly good. The surface is hilly and rolling, in some places stony and rough. There is no timber of any kind on any part of the township, not even scrub. There are scarcely any hay lands, only in places there is some tall grass around the ponds. There are some nice ponds of good water and there is a lake partly in section 1 and one in sections 8, 9, 16 and 17, both of which are alkaline. There are no streams of water and consequently no water-powers. There is no fuel to be had in the township and fuel would have to be obtained from outside places as there are no indications of either coal or lignite. There are no indications of stone anywhere, nor are there any minerals to be found in the township. Game of all kinds is scarce, only a few ducks on some of the ponds. Taking the township as a whole it is better adapted for ranching than for any other purpose.—*James Warren, D.L.S., 1906.*

12. The route to this township is by trail from Moosejaw, which is a very good trail with no bad hills or soft places. The soil in this township is generally clay, which in places would be fairly well adapted for cultivation, and many settlers have taken up land and are settled on their homesteads. Some have very good crops where they have cultivated the land. The surface is general undulating prairie entirely free from timber of any kind, nor is there any timber near the township. There are some hay lands but of a very limited extent. There are some ponds which have good fresh water, but some of the ponds or lakes are alkaline. In sections 19 and 30 there are two good large lakes, but both are alkaline. The supply in these lakes appears to be permanent. There are no streams of any kind and consequently no water-powers. The climate appears to be good and not liable to summer frosts. There are no stones or minerals of any kind, nor does there appear to be any coal seams near the surface. Game is scarce, there being only a few ducks on the ponds. This township is fairly well adapted to farming, but on the whole, ranching would be preferable on account of the surroundings, though when the land is cultivated I have no doubt good crops will be obtained.—*James Warren, D.L.S., 1906.*

50. This township is situated about seven miles from Prince Albert, and is reached by the Candle lake trail, entering section 1 and leaving at section 24. The trail is very heavy and in poor condition. The soil is a fine, rich, black loam. The surface is entirely wooded, being covered with poplar, spruce, jackpine and willow. The

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 25—Continued.

poplar averages from two to eight inches. A belt of jackpine extends across the south of the township averaging from four to twelve inches. Spruce from four to twenty inches is found in small groves all over the township. Large hay sloughs are found in every portion of the township, particularly the southwest corner, the hay being of a second-class quality. The water is fresh. Garden river cuts across the northeast corner of the township entering on the north boundary of section 33 and leaving at the northeast corner of section 13. It is a stream of good water, fifty links wide, three feet deep, with a current of two miles per hour. This township, generally speaking, is under water, especially the south and west portion. This portion has no drainage and could only be drained at great cost. There is no water-power. The climate in summer has been mild. There was considerable rainfall in June and July. There have been no summer frosts up to the present time (29th August). There is an unlimited amount of fuel. No coal, stone or minerals are to be found here. Duck, deer and moose are plentiful.—*R. H. Montgomery, D.L.S., 1906.*

51. The northwest part of the township is broken by a lake which partly covers sections 31, 19, 29 and the whole of 30. The body of the lake is crescent-shaped with the discs towards the north. There are numerous small shallow lagoons surrounding the lake, from one to three feet in depth and from one to five acres in extent. They are connected with the lake by narrow channels. There is a very good hay meadow around the margin of the lake and reaching back a distance of from a half to three-quarters of a mile, on which there was cut this season about three hundred and fifty tons of hay. I am of the opinion that three thousand tons could be cut at this place, as the ground is dry, smooth, and free from hummocks and willow. Section 31 is partly broken by the lake. The balance is low, swampy, and timbered with balm of Gilead, poplar and willow. Section 32 is low, with willow bordering the sides of the dry creek bed leading from the lake into Garden river, through the southeast quarter of section 32 to the outlet on section 33. On section 28 there is a large hay meadow surrounding a long narrow slough. The hay meadow extends from the lake meadow through section 28 to near Garden river on section 27. The south half of section 28 is timbered with poplar two to five inches in diameter, and a few scattered spruce. There is a small bluff of spruce on section 29, the rest being covered with hay meadow and lake. Section 27 is all timbered with poplar. On the northwest quarter of section 21 there is a small hay meadow. The rest of the section is timbered with balm of Gilead and poplar from two to five inches in diameter, except the southeast part of the southeast quarter, which is open, the soil being black sandy loam throughout. Garden river is sixteen feet wide, from one to three feet deep, stony bed throughout its course, and its current is two miles per hour. It enters the township on the approximate location of section 33, turning in a southerly direction through section 33, northeast section 28 and southwest 27, then through the centre of sections 22, 13, 10 and 3. From section 22 extending along the stream, the land rises gently until there is an elevation varying from thirty to fifty feet above the river, continuing in undulating slopes on both sides of the stream to section 3. The high land on the west side of the river falls in a gently undulating slope until a level is reached at the west boundary of sections 16 and 8. There is a continuous open space from section 22 to south boundary of township, from half to three-quarters of a mile on each side of the river. This area was burned over several times during the past twenty years. The soil alternates from black sandy loam to heavy clay, with a sandy clay subsoil. Peavine, vetches and excellent ridge hay are in evidence everywhere on the open area. The river is at a low stage, and fordable at scores of places between the north and south boundaries of the township, with excellent approaches on both sides. The high land on the east side of the river between sections 22 and 23 drops almost imper-

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 25—Continued.

ceptibly towards the east boundary. There are open spaces, caused by fires some years ago, which are partly covered with willow and small poplar and hay meadows, from twenty-five to two hundred acres in extent, nicely distributed over the east half of the township. On section 25 there is a spruce bluff, about twenty acres in extent, of good building timber. There is another on section 35, of about thirty acres, suitable for building purposes. The soil alternates from black sandy loam to heavy blue clay. There is a good trail to the township, which was made some years ago from Prince Albert, through township 49, range 26, crossing Little Red river at section 22, running north to the southwest corner of township 50, continuing in a northeasterly direction to section 3, township 51, range 25, then through sections 3, 10, 15, 22 and 21 to the lake. There is also a trail branching off at section 22, fording over Garden river and continuing through sections 23 and 24; then in a northeasterly direction to Candle lake. The whole of this township is very suitable for mixed farming.—*A. L. Robertson, Forest-ranger, 1906.*

52. *North outline.*—The surface is undulating, the timber, a light growth of poplar, occurring not continuously but in patches. There is much partly open land with willow bushes and small poplar. Thick poplar occurs across the east half of section 36. The soil is generally good. There are many sloughs and hay meadows, especially on section 31. Garden river (formerly called Sucker creek) flows southerly across the township. It is fifteen feet wide where it crosses the north outline.—*J. N. Wallace, D.L.S., 1906.*

Range 26.

11. The route to this township is by trail from Moosejaw. This trail is a very good one, especially in the summer, there being no hills or any wet marshy places. The greater portion of the soil is hard clay, which is not suitable for agricultural purposes. Generally the township is better adapted for ranching than for farming, as the pasturage is fairly good, and there is plenty of water. The surface is open prairie, in many places quite hilly, and in some places quite rough. There is no timber of any kind in the township, being all quite bare. There are a few small hay marshes, but not of any extent. There are several ponds and three of them especially are large, lake Agnellice, lake Petallen and lake Freda. The water in these lakes is quite alkaline, but there is a very nice spring near the northwest angle of lake Agnellice, which is very good water. There are no streams of water in any part of the township. Fuel is entirely wanting; so much so that we had to bring our wood from Moosejaw. There are no indications of minerals, coal or stone. Game is also scarce, there being only a few ducks on the ponds or lakes. From the general features of the township it is better adapted for ranching than for any other purpose. There are no ranchers located on any part of the township, though there are many good locations as there are some ravines that would give good shelter.—*James Warren, D.L.S., 1906.*

12. The route to this township is by trail from Moosejaw. The trail is a very good one and generally level with no bad hills or marshes on the route. The greater part of the soil in this township is very hard and not in any way favourable for farming or agriculture. The land is better fitted for ranching purposes as the surface is entirely open prairie. There is no timber of any kind on any part of the township. There are some good hay lands, but of a limited extent. There are many ponds in the township, some of which are very good water, but some are quite alkaline. There are no streams of water on any part of the township and consequently no millsites or water-powers. Fuel is entirely wanting, we had to draw our wood from Moosejaw.

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 26—Continued.

Stone is abundant in some localities, but no quarries. There are no indications of coal in any exposure on the hills. Game is scarce, only a few ducks on the ponds being seen. There are two ranchers located on section 12 who have a very good outfit of horses and cattle, and a comfortable location.—*James Warren, D.L.S., 1906.*

51. This township lies by trail some fifteen miles north of Prince Albert. This trail follows the east bank of Little Red river and is not in good condition. The western portion of this township is covered by a light sandy loam, and the eastern half by a black loam about six inches deep with a clay subsoil. The western half along Little Red river is covered by a light poplar and willow scrub and the eastern half by poplar averaging from four to ten inches with a dense hazel underbrush. Spruce in sufficient quantity for building purposes for the settlers, will be found in sections 30, 29 and 35, averaging from four to twenty inches, but not in large quantities. Hay can be found in moderate quantities along Little Red river and around the lake which lies in the northeast corner, the shores of which are low and covered with hay. The quality is second class. All the water in this township is fresh and the supply permanent. Little Red river is a stream forty feet wide, six feet deep, with a current of two miles an hour. It enters on the west boundary of section 31 flowing south and east leaving on the south boundary of section 4. This river is used by lumber companies for driving logs. There is a lake on the southwest corner of this township, the east shore of which has a sandy beach while the west is low and marshy. There is no water-power available. The climate is mild. Dead wood can be found all over the township for fuel. There is no coal, stone or mineral to be found. Game is scarce. The provincial government is building a road due north from Prince Albert entering this township on the south boundary of section 4, making the distance to town ten miles.—*R. H. Montgomery, D.L.S., 1906.*

52. *North outline.*—This township is rolling and is generally timbered with poplar varying from two to twelve inches in diameter, with many small willow marshes. There are many small ponds and sloughs. Sections 33 and 34 are the most thickly timbered on the north outline.—*J. N. Wallace, D.L.S., 1906.*

Range 27.

7. The best route for reaching this township, distant about sixty miles southerly from Moosejaw, is by way of the trail from Moosejaw to Willowbunch. This trail is generally in good condition, though it is somewhat hilly in places. The soil is chiefly sandy clay or clay loam with a stiff clay subsoil in places and would be suitable for growing all the usual cereals and vegetables of the Northwest. The western and northern portions of this township are hilly and somewhat broken in places, but the eastern and southern portions are rolling. A small amount of scrub cherry trees in the bottoms of some deep coulées in sections 33 and 34 is the only scrub in this township. All the rest of the township is open prairie. There is no timber. Little or no hay could be cut in this township but practically the whole township is covered with a good quantity of upland grass suitable for grazing purposes. Water only slightly alkaline, can be procured in dry seasons in sections 25, 26, 28, 33 and 36. Elsewhere there is little or no water. A large spring of good water exists in the northwest quarter of section 28, but soon after leaving the spring it becomes impregnated with alkali. In the above-mentioned sections the supply of water is sufficient and permanent. A deep valley runs through portions of sections 6, 7, 8, 17, 18, 20, 28, 29 and 30. The lands in the bottom of this valley are liable to be flooded for a short time in the spring. No water-power could be generated in this township. During the early part of September when this township was subdivided, fine warm days and cool nights were experienced. There is no wood for fuel in this township. There exists a vein

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 27—Continued.

of black lignite in a valley in the northeast quarter of section 28, about ten chains in a southwesterly direction from the northeast corner of the section. The vein lies in a horizontal position, and the part that had been uncovered consisted of two veins, each about one foot thick and about six inches apart. This lignite burns freely when in large pieces, but on exposure to the atmosphere it quickly decrepitates and becomes a mass of 'slack.' A strong spring of good water comes out of this vein. In fact in this part of the district wherever coal or lignite occurs water also is to be found, and though the reverse has not been proved to be true in many cases where springs exist considerable quantities of lignite have been picked up. A considerable number of boulders and stones exists on the surface, but no stone in place was observed. No economically valuable minerals, with the exception of the above-mentioned lignite, were seen. Some antelope, a few prairie chicken, geese, ducks and rabbits were seen. *H. S. Holcroft, D.L.S., 1906.*

8. The trail from Moosejaw to Willowbunch passes through the westerly part of this township and forms the best way of getting to it. This trail is in good order but is somewhat hilly in places. The soil of this township is, generally speaking, clay. But clay loam and sandy clay appear in many places as a surface soil. In some places, particularly in the western range of sections, a layer of alkaline-impregnated earth exists at the depth of a few inches below the surface. This deposit varies in thickness from a few inches to two or three feet. Stones and gravel occur in a few places though not in large quantities. This township is well suited for grazing or general farming purposes. This township is open, rolling prairie, somewhat hilly in the eastern portion, sections 6 and 7 being the only portions that are nearly level. No timber is to be found upon this township. Hay marshes of varying size, averaging about twelve acres in area, are well distributed over the township. These marshes contain a luxuriant growth of wild hay. A good quantity of upland grass grows all over the township. There are no lakes or rivers in this township. A few sloughs occur in the northeastern portion of the township, but all the water is too alkaline for human consumption with the exception of a spring beside the Moosejaw and Willowbunch trail in the northwest quarter of section 32. This water is slightly alkaline also. It is called the 'Twenty-five-mile Spring,' being twenty-five miles northerly from Willowbunch. This spring is the only permanent drinkable water in the township. None of the land is liable to be flooded to any greater extent than is caused by the melting of the snow together with the spring rains. No water-powers occur in this township. During the first week in September, in which this township was subdivided, the weather was warm and dry with cool nights but no frosts. There is no fuel in this township, the nearest wood being about ten miles southerly in townships, 25, ranges 27 and 28, where there is some cottonwood and poplar. Lignite can be procured from a vein in township 7, range 27. No coal or lignite veins were seen in this township. No stone in place was seen in this township. No minerals of economic value were encountered. Ducks of different kinds, a few geese and some antelope were seen.—*H. S. Holcroft, D.L.S., 1906.*

52. North outline.—Sections 31, 32 and 33 are rolling with a light growth of small poplar and are good land. Section 34 is wet and swampy with tamarack. Sections 35 and 36 are dry and rolling and generally, but not heavily, timbered with poplar and willow. The land is nearly all good along this range.—*J. N. Wallace, D.L.S., 1906.*

Range 28.

7. The most accessible route to this township is from Moosejaw, about sixty miles northerly on the Canadian Pacific railway. The trail from Moosejaw to Willowbunch, which passes through section 36 of this township, is a good trail to travel on

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 28—Continued.

in dry weather, but is somewhat hilly for a considerable portion of its length. The soil is principally clay, varying from that to sandy clay and clay loam, and should be suitable for growing all the usual cereals and vegetables of the district. It is somewhat stony in the bottoms of the coulées. A long valley through which the Moosejaw and Willowbunch trail runs, extends along the whole length of the east outline and a 'bottom' runs along the north boundaries of sections 34, 33 and 31. Coulées run back from both sides of these 'bottoms' into the township to a distance varying from a half mile to one mile, and these make the eastern and northern portions somewhat broken. Elsewhere the township is mainly gently rolling open prairie. There is no timber in this township at all. A few scattered hay-meadows are located in this township, but very little hay can be cut. The bottom lands along the northern outline would furnish a lot of good hay if cut early in the year. A fresh water slough is to be found on the east boundary of section 13. A spring at the southeast corner of the township and a spring of only slightly alkaline water in the northwest quarter of section 35, form the only bodies of fresh water seen in this township. The north and south outlines are liable to be flooded to the depth of about two feet or so for a while in the springtime. This is the only land liable to floods. The supply of fresh water at present is permanent though hardly sufficient. No water-power can be generated. The climate is the usual climate of the district; hot days and cool nights. Summer frosts, I believe, do not often occur. During the month of September, when the township was being subdivided, the days were fine and warm and the nights moderately cool. No frost was experienced. There is no fuel in this country, but poplar can be procured in the township to the south. No coal or lignite veins were encountered. No rock in place was to be seen and no mineral of economic value. A considerable number of ducks, mostly gray, blue and green wing teal and spoonbills, were seen. A few antelope and geese were also seen. Prairie chickens and jack-rabbits were very scarce.—*H. S. Holcroft, D.L.S., 1906.*

81. This township is most easily reached by the trail from Moosejaw to Willowbunch, which passes through section 1. Moosejaw is distant about sixty-five miles northerly, and is the nearest railroad point. The Moosejaw-Willowbunch trail is in good condition, but some parts are hilly, which makes travelling difficult after rain. The soil of this township is generally a stiff clay, with patches of sandy clay and gravel. The western range of sections are nearly all of a heavy clay loam. All the soil is first class and should make good agricultural land. This township is entirely open, rolling or hilly prairie. A few hills, about sixty feet high, occur in sections 4, 5, 8, 9, 20 and 21. The remainder of the township is rolling. There is no timber at all upon this township. Small hay meadows containing a heavy growth of wild hay are to be found distributed well over the township. Lake of the Rivers, or, as it is locally called, 'River lake,' is the only permanent body of water in this township. This lake cuts off portions of sections 19, 30 and 31, but is too highly alkaline for human consumption. At present fresh water can be secured from a spring in the northeast quarter of section 35, township 7, range 28, but this supply is not sufficient. None of the land is liable to be flooded. Water-power could not be generated in this township. During the period of subdivision of this township, viz., the second week in September, the weather was warm during the day and cool at night, with a few light frosts and some rain. No fuel exists in this township. The nearest procurable wood is in township 6, in ranges 27, 28 and 29, where there is a quantity of small cottonwood and poplar. No coal or lignite deposits were seen. No stone in place nor any economically valuable minerals were seen. Considerable numbers of ducks of various species, a few antelope and jack-rabbits were the only variety of game seen.—*H. S. Holcroft, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 28—Continued.

9. The trail crossing township 11, range 28, is the best one for reaching the part of the township to the west of Lake of the Rivers. The trail running from Moosejaw to Willowbunch passes through the east part of the township. The soil is all clay, but very little is suitable for farming. The east halves of sections 29 and 32 and sections 28 and 33 are suitable for farming. The south halves of sections 2, 3 and 4 are suitable for farming. The remainder of the township is rolling and hilly, and more suitable for grazing. There is no timber in the township, but there is some scrub in coulées running back from the lake in sections 6 and 7. There are no sloughs suitable for hay, and the upland grass is short and not very thick on the ground. The water in Lake of the Rivers is slightly alkaline. There is a good fresh water slough on section 1. There is a fresh water spring in section 15, and also smaller springs along the lake shore in sections 23 and 35. There are no streams and no available water-power. Wood and coal for fuel can be procured at Willowbunch. There are no lignite or coal veins in the township. There are no stone quarries or minerals of economic value. Small game such as chickens, rabbits and foxes were quite plentiful to the west of the lake. There were large flocks of ducks, geese and pelican on the lake at the time of survey (October). No antelope were seen, but this was probably due to the fact that the grass had been burned by a prairie fire just previous to the time of survey.—*C. M. Teasdale, D.L.S., 1906.*

10. The trail from Moosejaw to Willowbunch runs through the part of the township to the east of Lake of the Rivers. The westerly part of the township is more easily reached from Wood mountain trail, in township 11, range 29. The soil to the east of the lake is mostly a sandy loam and, being very rolling, is best adapted to grazing. The soil to the west is a heavy clay, and though in most parts the country is rolling, it could be mostly brought under cultivation. There is a little willow scrub along the lake shore in sections 3, 9 and 16, but there is no timber. There is some good hay land around a slough in section 6. There are good springs near the lake shore in sections 33 and 16. There are also several springs on the east side of the lake in section 36. There are no fresh water sloughs and no creeks. There is no available water-power. We had some frosts during the survey of the township (September and October). There is a two-foot lignite vein in section 36, but it was impossible to tell what the quality of the coal was, as the surface was badly weathered out. There are no stone quarries or minerals of economic value Small game is quite plentiful, especially in the rougher parts along the lake, there being chickens, rabbits and foxes. Geese, ducks and pelican are found in large flocks on the lake. Several large herds of antelope were seen during the survey.—*Chas. M. Teasdale, D.L.S., 1906.*

11. There is a good trail crossing the northeast of the township, which is the best way for reaching the easterly portion of the township. The portion of the township to the west and south of Lake of the Rivers is more easily reached from Wood mountain trail passing through township 11, range 29. The soil is largely clay, but in the more rolling parts and adjacent to the lake there is considerable gravel. The township as a whole is best adapted to grazing, although there are a few sections suitable for farming. There is no timber and only a few small bunches of willow scrub along the east shore of the lake. There are no natural hay lands. The water in the lake is slightly alkaline, but there are some good fresh water springs along the shore. There was no water in the sloughs at the time of survey (September). There are no streams and no available water-power. There were no indications of severe frosts at time of survey. Willowbunch is the nearest point where one can get coal and wood for fuel. There are no coal or lignite veins in the township. There are no stone quarries and no minerals of economic value are known. Game is very plentiful. Large flocks of geese, ducks and pelican are found on the lake, and foxes, coyotes, rabbits and badger are

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 28—Continued.

found in the hills around the lake. Several herds of antelope were seen in the township.—*Chas. M. Teasdale, D.L.S., 1906.*

52. *North outline.*—This range comprises only the fractional section 36. It extends on both sides of Little Red river. The surface is rolling and is about half prairie and half poplar and willow. Except for a small swamp area just east of Little Red river, the land is very good.—*J. N. Wallace, D.L.S., 1906.*

Range 29.

7. The trail from Moosejaw to Willowbunch passes about six miles to the eastward of this township and affords the easiest means of access to it. The Moosejaw and Willowbunch trail is a good trail but is somewhat hilly in places. The soil is clay or clay loam or sandy clay. It is somewhat light in places but should produce good crops of wheat and other cereals as well as all varieties of the vegetables of the province. Parts of sections 24, 25, 26, 35 and 36 are somewhat broken by coulées and hills. The remainder of the township is open rolling prairie. No timber at all exists. A few tons of wild hay could be cut in the southwestern portion of the township, but excellent grazing exists all over the township. A small creek bed in the north of sections 34, 35 and 36 collects and holds rain and snow water, but in the very dry season this water becomes alkaline and not fit for human consumption. A shallow lake in the southern portions of sections 1 and 2 contains water, which though alkaline may be used. Beyond some few hay-meadows which hold rain water for a short while, no water exists. The supply of water is not sufficient or permanent. No water-power could be generated. The climate is good. Summer frosts, I believe, are rare. There is no fuel in this township, but poplar may be procured in a large 'bottom' or valley about four miles southward in townships 6, ranges 29 and 30. No stone in place is to be found. No minerals of economic value were seen and no coal or lignite veins were seen. A fair number of ducks was seen, also some antelope and jack-rabbits. Coyotes, red foxes, and kit foxes were plentiful. Other game was scarce.—*H. S. Holcroft, D.L.S., 1906.*

8. The nearest railway station to this township is Moosejaw. The trail from Moosejaw to Willowbunch is at present the best route to follow in reaching this township. This trail must be left in section 1 of township 8, range 28, where a wagon road leaves the main trail and goes westerly through a valley which ends at the south of the Lake of the Rivers. This is a long narrow crooked lake with strongly alkaline water which occupies most of the two eastern ranges of sections. This trail is in good condition in dry weather, but would be heavy when wet. All this township except the part adjoining the lake has a clay loam with sandy loam and sandy clay in some places. This township is very suitable for agricultural purposes as the soil is good and the surface partly rolling. The land to the east adjoining the lake is broken by coulées which run back from the lake and the soil is rather stony and gravelly. About thirty squatters' shacks are set up in this township, mostly congregated about the centre. There is no timber or scrub in this township and only a very little hay could be cut. In the northern portion there are a few small hay-meadows on which grows a light crop of poor hay. Excellent upland grass for grazing purposes is to be had all over the township. There is no fresh water in the township, although in a valley in the southeastern portion there is a creek bed which collects the rain water, but this soon becomes alkaline. The water in the Lake of the Rivers is intensely alkaline. This lake is considerably lower than the rest of the township and is surrounded by high banks which are much broken by deep and long coulées. The lake is shallow and in many places contains a growth of rank grass. No water-power could be de-

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 29—Continued.

veloped. No coal or lignite veins are known to exist. Fuel in the shape of small poplar can be procured in township 6, range 29, about fifteen miles southerly. No stone in place exists. No minerals of economic value were seen. There are a few antelope, ducks and jack-rabbits. Prairie chickens are scarce. The small game is largely destroyed by the great number of hawks, coyotes and foxes which are found all over the township. An occasional sand-hill crane or a pelican may be seen.—*H. S. Holcroft, D.L.S., 1906.*

9. This township is most easily reached from trail in township 11, range 29. The soil is principally clay, and is mostly suitable for farming. Sections 35, 36, 25, 26 and 24 are hilly and best adapted to grazing. There is no timber or scrub. Large quantities of slough hay could be cut around the large slough in sections 26, 27, 33 and 34. Upland hay could be cut in the southwesterly part of the township, as the land is lighter and the grass much heavier than in the rest of the township. There is water in the slough in sections 33 and 34, and also in a small slough in section 26. There was no other water in the township at the time of survey (October). There are no streams and no available water-powers. There are no coal or lignite veins in the township, but there is both coal and wood at Wood mountain, in township 4, range 3, west of the third meridian. There are no stone quarries or minerals of economic value. There are a few antelope, chickens and ducks in the township.—*Chas. M. Teasdale, D.L.S., 1906.*

10. This township is reached from Moosejaw by the trail passing through township 11, range 29. The soil is mostly clay or clay loam, but is generally too rolling to make good farming lands. Sections 36, 7, 8, 9, 16, 17 and 18 are hilly and gravelly, and suitable only for grazing. The surface is all prairie, there being no scrub or timber. There is a large slough on sections 31 and 32, which was partly dry at time of survey (October), and would be good hay land. There is a smaller slough on section 3, parts of which could be cut for hay. Besides these there are numerous small sloughs all over the township suitable for hay. The upland hay is very short. There is fresh water in several sloughs. Besides the sloughs on sections 3, 31 and 32, there is water in sloughs in sections 7 and 8, and a good spring near the quarter-section on the north boundary of section 19. There are no streams and no available water-powers. Both coal and wood can be had at Wood mountain, in township 4, range 3, west of the third meridian, but there are no coal or lignite veins in the township. There are no stone quarries or minerals of economic value found in the township. Antelope, chickens and ducks are quite plentiful.—*Chas. M. Teasdale, D.L.S., 1906.*

11. The trail from Moosejaw to Wood mountain crosses the township in a southwesterly direction, entering in section 35 and leaving it in section 18. The northerly two tiers and the easterly tier of sections are inclined to be gravelly, but the remainder of the township is clay and clay loam. The northerly and easterly portions of the township are suitable only for grazing, while in the remainder there is some good farming lands. It is all open, rolling prairie, without any scrub or timber at all. There are no large hay meadows in the township, although there are a few small sloughs suitable for hay. Water is not plentiful, and at the time of survey (August) there was good water in a slough on section 23. There is a spring in section 27 on the trail. There are no permanent creeks, but in the spring there is water in the valley in sections 33, 34, 26 and 25, and in some places there is a distinct bed. There are no available water-powers. Vegetation showed no signs of frost at time of survey. Coal is mined at Wood mountain, and wood can also be obtained there. There are no coal or lignite veins known in the township. There are no stone quarries or economic minerals. Game is fairly plentiful. Several herds of antelope were seen during the survey. Chickens are quite plentiful in the rougher parts. There are large numbers of foxes and badgers.—*Chas. M. Teasdale, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 30.

6. *East outline.*—The trail from Wood mountain to Willowbunch crosses the east boundary of section 12 in this township and forms the easiest way to reach the township. The soil is mainly clay, being somewhat stony in places. It would probably grow good wheat and the usual cereals of the district. A large bottom, or valley, about one and one-half miles wide along which the Willowbunch and Wood mountain trail runs, enters the township on the east boundaries of sections 1 and 12 and passes southwesterly through the southerly portion of the township. This bottom is level and contains a large quantity of good hay. The soil here is a heavy clay. This valley contains a considerable amount of poplar up to three inches in diameter. The remainder of the township appears to be open rolling prairie, being somewhat rough in places and would make excellent grazing country. Several hay meadows are scattered throughout the township. The bottom mentioned above contains several good springs of fresh water, which are permanent and would give a good supply of water. This bottom is flooded in spring time for a while. No water-powers exist. During the month of September while this boundary was being run the climate was very mild, and only one light frost occurred. Fuel in the shape of poplar can be procured all along the Willowbunch valley in the southerly part of the township. No coal or lignite veins were seen. No bed rock was seen, and no economically valuable minerals were encountered. Antelope, ducks of various kinds, and geese were plentiful. A few prairie chicken and jack-rabbits were seen. Other game appeared to be scarce.—*H. S. Holcroft, D.L.S., 1906.*

7. The nearest trail to this township is the trail from Willowbunch to Wood mountain, which passes through township 6, in range 30. The greater part of the soil of this fractional township consists of a loam mixed with clay and sometimes with sand, and should be capable of producing good crops of all the usual cereals and vegetables of the province. The township is open rolling prairie with only a small quantity of good hay growing in some small hay marshes scattered throughout the township. Two hay marshes of considerable size are located on the east boundaries of sections 12 and 13 respectively. Water of a fair quality is found in a shallow marshy lake in the northeast portion of the township. This supply is sufficient and permanent. No water-powers exist here. The climate is the usual climate of the district—moderately equable. During the time this township was subdivided, viz., the first week in October, some frosts occurred, but the weather was pleasant. There is no fuel in this township, but fuel consisting of poplar, could be procured in a valley about four miles to the south. No veins of lignite or coal were seen. There is no rock in place and no economically valuable minerals were discovered. A good many ducks and geese were seen, also a few sand-hill cranes, swans and pelicans. Prairie chickens and jack-rabbits were scarce. An occasional antelope was seen; coyotes and foxes were plentiful.—*H. S. Holcroft, D.L.S., 1906.*

8. The trail from Moosejaw to Willowbunch passes twelve miles to the east of this township. In section 1, township 8, range 28, a well beaten trail leaves the Moosejaw and Willow bunch trail and goes westward to this township. These trails are good but parts of them are liable to be flooded in spring time. The soil is clay loam or sandy clay; it is a little light in places but should produce good crops of wheat and other cereals and all the usual vegetables of the Northwest. The surface of this fractional township is almost all level country. No timber at all is found. A small amount of hay could be cut from some small hay meadows in the northwestern portion of the township. At the time of the survey no water was found in the township. In spring time some of the depressions in the surface contain water, but during the dry season water cannot be found. None of the land is liable to be flooded except for a short time in the spring. No water-power could be developed. The

TOWNSHIPS WEST OF THE SECOND MERIDIAN.

Range 30—Continued.

climate is good, in summer time, hot days and cold nights. Summer frosts are rare. There is no fuel to be obtained in this township. Some small poplar can be procured in a valley about ten miles to the south. There are no coal or lignite veins and no bed rock. No minerals of economic value were seen. Some antelope and jack-rabbits were seen. Prairie chickens are very scarce on account of the great number of hawks that abound. Coyotes and foxes were numerous.—*H. S. Holcroft, D.L.S., 1906.*

9. This township is reached from Moosejaw by Wood mountain trail, which passes through township 11, range 30. The soil in the north part is a heavy clay, which turns to a clay loam in the south part. The portion north and west of sections 15, 23 and 25 is rolling and more suitable for grazing, while the part to the south is more level and suitable for farming. It is all open prairie without any timber. There are some sloughs in sections 9 and 10 suitable for hay. There is a clear fresh water lake on section 22. There are no streams or no available water-powers. Wood mountain, in township 4, range 3, is the nearest point at which wood and coal is obtainable at present. There are no stone quarries nor economic minerals in the township. Antelope are found in small herds which water at the lake. On the lake there are large numbers of ducks.—*Chas. M. Teasdale, D.L.S., 1906.*

10. This township is best reached by Wood mountain trail, which passes through township 11, range 30. The soil is mostly clay, but some lighter soil is found in section 36. The northerly halves of section 35 and section 36 are fairly level and should be good wheat land, but the remainder of the township is very rolling, and parts of sections 22, 23, 14 and 13 are hilly and inclined to be gravel instead of clay, especially on the ridges. This latter part would be more suitable for grazing than farming. There is no timber. There is one large hay meadow on section 35, which at time of survey (October) was perfectly dry. There is a large deep slough on section 12, and some small sloughs occur in sections 14 and 23. The water is all good, being practically free from alkali. There are no streams and no available water-powers. No severe frosts had occurred at the time of survey, as the grass on what had been burned in September was quite green. There is no coal or wood in the township, but both can be obtained at Wood mountain. There are no stone quarries or minerals of economic value. There are a few antelope, chickens and ducks in the township.—*Chas. M. Teasdale, D.L.S., 1906.*

11. There is a good trail running from Moosejaw to Wood mountain, which crosses the southerly portion of the township. The soil is a heavy clay, except in the northerly part of sections 35 and 36, where it is a light sandy loam. The clay soil should make good wheat growing land. The north part of the township is rolling prairie, but sections 11, 12, 1 and 2 are gently rolling prairie more suitable for farming. There is no timber in the township. There are no hay meadows. At the time of survey (September) there was no water at all in the township. There are no available water-powers. There were no indications of summer frosts. There are no coal or lignite veins in the township, but coal is mined at Wood mountain, in township 4, range 3, west of the third meridian. There are no stone quarries or minerals of economic value. Game is scarce, although at times there are a few antelope, and in the sandy portion at the north of the township there are some prairie chickens.—*Chas. M. Teasdale, D.L.S., 1906.*

14. The soil in this township is very hard and in many places stony and gravelly, and not well adapted to agriculture. There are some patches of hay land, but the hay is not very good.—*James Warren, D.L.S., 1906.*

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 1.

51. The northern fraction of this township lies some twenty-three miles from Prince Albert. It is reached by the surveyed road from Prince Albert to Sturgeon lake. This road enters the township on the south boundary of section 25 and leaves on the east boundary of section 36. Its condition is excellent. The soil is composed of clay, and in a few cases there is black loam from six to twelve inches overlying it. The southwest fraction has some rich black loam, and should prove excellent for farming of a mixed character. This township has been covered by a heavy growth of large poplar and spruce, averaging from six to twenty-four inches, but being in a timber berth the best has been taken away. What good timber is left would be difficult to obtain, owing to the rough character of the ground caused by the culls remaining. These could only be removed by bush fires. There are hay sloughs in sections 25 and 36. The quality is fair, but the quantity not extensive. Upland hay is to be found in sections 6 and 7. Water of fresh quality can be obtained in sufficient quantity in any part of the township. It is found in small creeks flowing into Sturgeon lake. This lake is an enlargement of the river of the same name. It is ten miles long and averages one-third of a mile in width. The north shore is very steep and heavily wooded. No water-power is available. The climate on the whole was mild, the first frost being on August 22nd. This township is covered by large windfall and dead wood, and fuel of this character will never be lacking. No coal or minerals were discovered. Stone and boulders were found. Game has been driven out. Whitefish and jackfish are plentiful in Sturgeon lake. The northern fraction of this township can scarcely become valuable as farming land unless the district becomes burnt over. In its present condition it is the most rough and rugged country imaginable.—*R. H. Montgomery, D.L.S., 1906.*

Range 2.

50. The northern part of this township can be reached by following the Shellbrook trail to the east boundary of this township; then going north and fording the Shell river. This trail is in good condition. The Shellbrook-Sturgeon lake trail passes through section 32. The soil is composed of black loam, six to twelve inches, with a clay or sand subsoil. It should prove a good mixed farming district. The land is lightly wooded generally with poplar, averaging from two to six inches in diameter. Sections 31 and 32 are covered by a light willow scrub. There is no timber. A little upland hay is to found in section 36. Owing to the proximity of Shell river little surface water is found, and the land is never liable to be flooded. There are no waterfalls. The climate is mild, the first frost being noticed on August 22nd. Dead wood can be obtained in abundance for fuel. No coal, minerals or stones were found. Game was very scarce.—*R. H. Montgomery, D.L.S., 1906.*

51. This township lies on the main trail to the Prince Albert Lumber company camps at Stump lake. This trail follows the Prince-Albert-to-Sturgeon lake surveyed trail to the east end of Sturgeon lake. It then follows the south shore of the lake and river, and enters the township on the east boundary of section 12, a distance in all of about thirty miles, leaving the township on the north boundary of section 31. The condition of this trail is excellent. The soil is composed of a rich black loam, generally twelve inches deep, with a clay subsoil. The land should be suitable for mixed farming. The surface is generally covered with poplar and willow. Sections 1, 12, 14, 23, 15 and 16 are covered with very light poplar and willow scrub. In the southwest and northeast corners of this township spruce averaging from four to thirty inches is found in large quantities. A considerable amount of this timber has been cut out by lumber companies. There is a large quantity of both upland and lowland hay, the upland being found in the southeast corner and the slough hay on section 10 and around lake No. 1. Water is scarce except in Sturgeon lake and river. Sturgeon

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 2—Continued.

river, one chain wide, enters on the north boundary of section 31, flows southeast to section 21, thence east to Sturgeon lake. Particulars concerning this river could not be obtained at the time of the survey, as it was dammed by the Prince Albert Lumber company, and the whole river valley was in a flooded condition. The banks of this valley are about one hundred and forty feet high, and, as numerous coulées run into it. the land will never be flooded. Sturgeon lake begins in this township; it is merely an enlargement of the river. There are no waterfalls. The climate is mild. On August 22nd the first frost was noticed. Dead wood for fuel can be obtained in abundance all over the township. There is no coal or minerals. Colour of gold can be obtained in the creek beds. Boulders were plentiful along the river valley. Game is scarce, but Sturgeon lake is teeming with white and jackfish. Several squatters were found in this township. Their chief industry is supplying hay to the lumber companies—*R. H. Montgomery, D.L.S., 1906.*

Range 3.

21. This township is about 30 miles north of Mortlach, a small town on the main line of the C.P.R., and about 35 miles west of Craik, on a branch line of the C.P.R., from which the settlers obtain building material and supplies. There are well beaten trails from both these towns to various parts of the township. The soil throughout is sandy loam, with occasional clay suitable for wheat, oats, flax and potatoes. The surface is undulating to rolling throughout. There is no timber or scrub of any description in this township. There are four small alkali lakes in sections 2, 13, 14, 15, 22 and 21. There are also several small alkali creeks in the northern half of the township. Wells are dug by settlers usually at a depth of from 30 to 70 feet, but the water is not always drinkable, owing to a strong alkali flavour. There are a few small hay sloughs in this township. Settlers obtain good hay from Qu'Appelle valley, some 10 miles to the north. From information obtained, and my experience, there are no summer frosts; on the other hand, very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, the settlers having to freight coal from Craik or Mortlach. No stone quarries were observed. A few antelopes and coyotes were seen. Our nearest postoffice was West Bridgford, situated in section 32, in the township to the north, to which the mail is brought from Craik once a week. A number of settlers were noticed building and ploughing, and from subsequent information I learned that all the homesteads were taken. Railway surveyors have laid out a trial line of the new extension line of the C.P.R. from Moosejaw to The Elbow, some six miles to the north of this township. As the settlers have generally only arrived on their homesteads this spring, the crop will not be very large, although considerable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

22. This township is about forty miles north of Mortlach, a small town on the main line of the Canadian Pacific railway, and about thirty-five miles west of Craik, on a branch line, from which the settlers obtain building material and supplies. There are well beaten trails from both these towns passing through various parts of the township. The soil throughout is sandy loam, with some clay and gravel, but on the whole is suitable for wheat, oats, flax and potatoes. The surface is undulating to rolling throughout. There is no timber or scrub of any description in this township. There is an alkali lake in sections 18 and 19, also alkali creeks in the northeast and northwest corners of the township. There is no other water. Wells are dug by settlers, and water is obtained usually at a depth of from thirty to seventy feet, but the water is not always drinkable owing to a strong alkali flavour. There are a few small hay sloughs in this township; settlers obtain good hay from Qu'Appelle valley, in the township to the north. From information obtained, and from my own experience,

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 3—Continued.

there are no summer frosts; on the other hand, very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, the settlers having to freight fuel from Craik or Mortlach. Small poplar scrub is obtained for fuel from the sand hills some eight miles to the north. There are no stone quarries. A few antelopes and coyotes were seen. West Bridgford postoffice is in section 32 of this township; the mail is brought from Craik once a week. A number of settlers were noticed building and ploughing, and from subsequent information I learned that all the homesteads were taken. Railway surveyors have laid out a trail line of the new extension line of the Canadian Pacific railway from Moosejaw to The Elbow, through the northeastern portion of this township. As the settlers have mostly only arrived on their homesteads this spring, the crop will not be very large, although considerable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

23. This township is reached by several well beaten trails, running from the small towns on the nearest railways, distant forty to fifty miles. The soil for the southern three-quarters is sandy loam, the remainder almost pure sand. We noticed several crops of excellent wheat and oats, and undoubtedly the soil of the southern part compares favourably with that of the surrounding district, in which all kinds of grain and vegetables are grown. The surface of that portion south of Qu'Appelle valley is rolling and undulating, that to the north comprises sand hills. Qu'Appelle valley, about a mile in width, extends across the township from east to west, through which flows Qu'Appelle river, a small body of water which, at the time of survey (August), was dry in numerous places. There is a little green poplar and willow of small dimensions in scattered clumps throughout the sand hills, suitable for fencing purposes and firewood. In connection therewith, I may say it is from these sand hills that the settlers around this locality procure their firewood. Hay is procurable from the valley of the Qu'Appelle in sufficient quantities to provide for all necessary wants of the settler at present. There are no lakes or sloughs, but water is quite plentiful in places in Qu'Appelle river and in several creeks which flow into it. There is a beautiful spring of excellent water in section 3, which furnishes an abundant supply. There is no flooded land, except in Qu'Appelle valley. From experience and inquiry, I would say that there are no summer frosts likely to do any injury to crops. I did not notice any signs of lignite veins or coal in this township; the only fuel is obtainable from Sand hills. There are no stone quarries, but numerous boulders were observed on the hilltops and in the ravines. There are several trails in this township, the principal one being the old Temperance Colony trail running to Saskatoon. The nearest post office is West Bridgford, situated in section 32, township 22, range 3, and is about forty miles from Craik, from which town the mail is delivered once a week. The proposed route of the extension of the Canadian Pacific railway, from Moosejaw to The Elbow, runs through the southern part of the township. With the exception of a few antelope, we did not notice any game in this township. I understand that all the lands south of the river that were open for homesteading had been entered for.—*E. W. Hubbell, D.L.S., 1906.*

50. The northern half of this township lies about thirty miles from Prince Albert. It can be reached by a trail branching off from the main Shellbrook-to-Prince Albert trail. The condition of this trail is good. The soil is composed of heavy black loam with a clay subsoil and is suitable for all kinds of farming. The surface is entirely covered with poplar bush and poplar and willow scrub. Poplar averaging from two to fourteen inches suitable for building timber can be found all over the township. There is a large quantity of hay of a second rate quality to be found in sloughs. The shores of Succor and Vant creeks are covered with hay of an inferior

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 3—Continued.

quality. A large slough with hay of good quality is situated on sections 29 and 30. There will never be any scarcity of water in this township. There are two creeks Succor and Vant, both about fifteen feet wide and two feet deep with a current of two miles per hour. Succor creek enters on the north boundary of section 36 and leaves on the east boundary of section 24, while Vant creek enters on the west boundary of section 19 and leaves on the east boundary of section 24. There is no water-power available although lumber companies have made use of Succor creek to drive logs down. No coal, stone or minerals were found here. The climate is mild. On August 22nd there was a summer frost destroying potato vines. There is no scarcity of dry wood for fuel. Ducks are abundant in this township.—*R. H. Montgomery, D.L.S., 1906.*

Range 4.

10. There are trails running to this township from Moosejaw and Mortlach. The soil is a good clay suitable for general farming. The surface is level prairie without timber except along the creek banks. The timber is mostly maple and is very rough and suitable only for fuel and posts. There is considerable willow which would make posts. There are no sloughs, but there is an abundance of upland hay all over the township. There are no sloughs containing water. The water in Old Wives creek is free from alkali. At the time of survey (November) it was not running, but there was several feet of water in holes all along the creeks. The creek banks vary from fifteen to twenty-five feet high. Water-power might be obtained for part of the year as the creek is deep and swift during the spring and summer. The supply of wood along the creek is only small but coal can be had at Wood mountain in township 4. There are no lignite veins, stone quarries or minerals of economic value in the township. Prairie chicken and rabbits are very plentiful along the creek. As water is scarce and very hard to get even by digging, I think it would be a good plan not to allow any homesteader who has settled on the creek a pre-emption on it.—*Chas. M. Teasdale, D L.S., 1906.*

21. This township is about thirty-five miles north of Mortlach, on the main line, and about the same distance west of Craik, on a branch line, of the Canadian Pacific railway. There are well beaten trails from both those towns. The soil throughout is sandy loam suitable for wheat, oats, flax and potatoes, but to insure a good crop considerable rain is necessary. The surface is undulating to rolling throughout. There is no timber or scrub of any description in this township. The only source of water supply in this township are the wells dug by settlers, usually at a depth of from thirty to seventy feet, but the water is not always drinkable owing to a strong alkali flavour. From information obtained and my experience, there are no summer frosts; on the other hand, very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, the settlers having to freight fuel from Craik or Mortlach. No stone quarries were found. A few antelope and coyotes were seen. Our nearest postoffice was West Bridgford, situated in section 32, township 22, range 3, and to which the mail is brought from Craik once a week. A number of settlers were noticed, at the time of survey (June), building and ploughing, and from subsequent information I learned that all the homesteads were taken. Railway surveyors have laid out a trial line of the new extension line of the Canadian Pacific railway from Moosejaw to The Elbow, some eight miles to the east of this township. As the settlers have mostly only arrived on their homesteads this spring, the crop will not be very large although considerable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 4—Continued.

22. This township is about 45 miles west of Craik (a small but thriving town, through which a branch of the C.P.R. runs), and is reached by a well beaten trail from that place. The soil throughout is sandy loam suitable for wheat, oats, flax and potatoes, but to insure a good crop considerable rain is necessary. The surface is open and undulating throughout. There is no timber or scrub of any description in this township. Good water is scarce; there are several alkali sloughs, also two small alkali creeks, one in the northwest part, the other in the eastern part of the township. Wells are dug by the settlers, and water is generally obtained at a depth of 30 to 60 feet, but it is not always drinkable owing to it having a strong alkali taste. There is no flooded land in this township. Some of the settlers obtain good hay from Qu'Appelle valley, distant about 10 miles. From information obtained, and my experience, there are no summer frosts; on the other hand, very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, nor stone quarries. The settlers have to freight fuel from Craik or from Mortlach, situated on the main line of the C.P.R., and about forty-five miles distant. Small poplar scrub can be obtained for fuel from the sand hills some ten miles to the north. Our nearest postoffice was West Bridgford, situated in section 32, township 22, range 3, and to which the mail is brought from Craik once a week. A number of settlers were noticed at the time of survey building and ploughing, and from subsequent information I learned that all the homesteads were taken. Railway surveyors have laid out a trial line of the new extension of the C.P.R. from Moosejaw to The Elbow, some four miles to the east of this township. As the settlers have mostly only arrived on their homesteads this spring, the crop will not be very large, although considerable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

Range 5.

21. This township is about fifty miles west of Craik, a small but thriving town, through which a branch of the Canadian Pacific railway runs, and is reached by a well beaten trail from that place. The soil throughout is sandy loam, suitable for wheat, oats and potatoes, but to insure a good crop considerable rain is necessary. The surface is undulating to rolling throughout. There is no timber or scrub of any description in this township. There are a few hay sloughs, but these were dry and there were no other signs of water, other than wells dug by settlers, in this township. Water is obtained at a depth of thirty to sixty feet, but it is not always drinkable owing to a strong alkaline taste. From information obtained and my experience, there are no summer frosts; but on the other hand, very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, nor stone quarries, the settlers having to freight fuel from the nearest station, which is Chaplin, situated on the main line of the Canadian Pacific railway, and about thirty-five miles distant. The only game is a few antelope in the southern part of the township. Our nearest postoffice was Log Valley, situated in section 34, township 20, range 8, and to which the mail is brought a distance of thirty-five miles from Herbert, on the main line of the Canadian Pacific railway, once a week. A number of settlers were noticed at time of survey, building and ploughing, and from subsequent information I learned that all the homesteads were taken. The lack of water is the great drawback of this section of the country. As the settlers have only arrived on their homesteads this spring, the crop will not be very large, although conidcrable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

22. This township is about fifty miles west of Craik (a small but thriving town through which a branch of the C.P.R. runs), and is reached by a well beaten trail

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 5—Continued.

from that place. The soil throughout is sandy loam, suitable for wheat, oats and potatoes, but to insure a good crop considerable rain is necessary. The surface is generally undulating throughout. There is no timber or scrub of any description in this township. There are a few sloughs, but these were dry and there were no other signs of water other than wells dug by settlers in this township. Water is generally obtained at a depth of 30 to 60 feet, but it is not always drinkable owing to a strong alkali taste. From information obtained and my experience, there are no summer frosts; but, on the other hand, hot weather generally prevails during the summer months We did not perceive any signs of coal or veins of lignite in this township, nor stone quarries, the settlers having to freight fuel either from Chaplin, situated on the main line of the C.P.R., and about forty-five miles distant, or from Craik. A few antelope and coyotes were seen. The original survey of this township was fairly well done. Iron bars minus the tins were found at nearly all the section corners, these of course being practically useless to the settlers, or land seeker. Stamped numbers on the few tins that were found have long since become unrecognizable. As a result, people hunting up their sections had great difficulty in ascertaining their locations. Our nearest postoffice was West Bridgford, in section 32, township 22, range 3; letters are obtained from there and Log Valley in section 34, township 20, range 8. A number of settlers were noticed at the time of survey, building and ploughing, and from subsequent information I learned that all the homesteads were taken. The lack of water and fuel is the great drawback in this section of the country. There is also difficulty in obtaining hay in the near vicinity. As the settlers have only arrived on their homesteads this spring, the crop will not be very large, although considerable land is broken and will be ready for next spring.—*E. W. Hubbell, D L.S., 1906.*

Range 6.

21. This township is about sixty miles west of Craik, and is reached by a well beaten trail from that place. The soil throughout is sandy loam suitable for wheat, oats and potatoes, but to insure a good crop, considerable rain is necessary. The surface is undulating to rolling, except the southern part which is rough and hilly, being on Vermilion hills. A valley about half a mile wide, with alkali bottom, runs across the southern part of this township in a southeasterly direction. There is no timber or scrub of any description on this township and the only noticeable sloughs situated in sections 16, 17 and 18 were dry. These sloughs doubtless furnish the settlers with most of their hay. Water is very scarce, in fact the only supply, except an occasional well, is from two springs situated in the southwest quarter of section 2 and the northwest quarter of section 18. The supply, though not large, is excellent. Wells are dug by the settlers and water is generally obtained at a depth of from 30 to 60 feet, but not always drinkable, it having a strong alkali taste. There is no flooded land in this township. From information obtained and my experience, there are no summer frosts, on the other hand very hot weather generally prevails during the summer months. We did not perceive any signs of coal or veins of lignite in this township, nor stone quarries, the settlers having to freight fuel from the nearest station, which is Chaplin, situated on the main line of the C.P.R. and about 35 miles distant. Stone outcropping and boulders were generally noticeable along the tops of ridges, in the valleys and on the hilltops. The only game is a few antelope in the southern part of the township. Our postoffice was Log Valley, situated in section 34, township 20, range 8, and to which the mail is brought a distance of thirty-five miles from Herbert, on the main line of the C.P.R., once a week. A number of settlers were noticed at time of survey, building and ploughing, and from subsequent information I learned that all the homesteads were taken. The lack of water and

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 6—Continued.

fuel is the great drawback of this section of the country. As the settlers have only arrived on their homesteads this spring, the crop will not be very large, although consiberable land is broken and will be ready for next spring.—*E. W. Hubbell, D.L.S., 1906.*

Range 7.

21. We reached this township, distant about 65 miles, via a well beaten trail direct from Craik, a small but thriving town on the Qu'Appelle branch of the Canadian Pacific railway. The soil throughout this vicinity is sandy loam, with occasional gravel, suitable for wheat, oats and potatoes, but, owing to its nature, considerable rain is necessary to guarantee a first-class crop. The surface of the northern and eastern portions of this township is undulating and rolling; the southern, hilly and broken, constituting a portion of Vermilion hills. The western part of the township is broken and hilly, caused by the huge ravines and gullies which extend into the South Saskatchewan, of which a portion flows through this township. There is no timber of any description, except a few clumps of small green poplar in the ravines which adjoin the river, and in the hills, but it is practically valueless, being too small for fencing purposes or firewood. Consequently, fuel is very scarce, and in the course of a few years will be the burning question. There being no sloughs or swamps of importance, hay is at a premium. The most of it is procured by the settlers from other localities, or cut in the bottom lands and ravines, the latter being of poor quality. Water is very scarce, the only supply being the river and two or three small creeks, most of the latter having a strong taste of alkali. Wells are dug by the settlers, and water is generally obtained at a depth of twenty to forty feet, but not always palatable. There is considerable alkali in this section of the country, which affects most of the water more or less. There is no flooded land in this township, and the only water-power is the ever reliable Saskatchewan river, upon which many reports have already been made by experts and surveyors for the government's information, and to these I can add nothing of any value. My knowledge and experience of the climate is that there are no summer frosts; on the other hand, the heat is terrific, and with such little rain as we have had this year, the tendency will be towards a lighter crop than usual. With too much heat and little rain wheat will not mature to advantage. I did not notice any signs of coal or veins of lignite in this township. As before mentioned, there is practically no fuel, coal having to be brought from Chaplin, the nearest railway station, about thirty-five miles distant. There are no stone quarries, but on the summit of Vermilion hills boulders are quite numerous. We did not observe any traces of minerals. A few antelope and small deer were occasionally seen, but the rapid rush of settlers to this district is gradually diminishing their numbers and driving them away. In a few years, like the buffaloes, they will be a thing of the past unless stringent methods are adopted to prevent their extermination. The old well beaten trail from Swift Current to Prince Albert runs through this township. Our nearest postoffice was Log Valley, situated in section 34, township 20, range 8, an almost inaccessible place, and to which the mail is brought from Herbert, on the main line of the Canadian Pacific railway once a week. Messrs. Hitchcock & Ferguson, ranchers, have leased and fenced sections 1, 12, 2, 11, 3 and 10 and the east half of sections 4 and 9. They have about 300 head of horses, also a number of cattle. All the land of any value open for homesteds has been taken, and the new settlers are hard at work ploughing and building, and appear satisfied with their selection and prospects.—*E. W. Hubbell, D.L.S., 1906.*

Range 8.

21. This township is approached by several fairly good trails from the north and west, but as yet it is very little settled upon. The soil is generally sandy loam, but

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 8—Continued.

close to the river it is sand and gravel. A few fields of wheat were noticed, but they were not of the best quality. I should say the soil would be suitable for vegetables, etc. With the exception of that part of the township which adjoins the South Saskatchewan, the surface is rolling and undulating; the portion adjoining the river, with an average width of one mile, is rough, hilly and broken with numerous ravines, etc. There is a little poplar, willow and ash along the river banks and in the ravines; some of the ash and poplar in sections 24 and 25 is suitable for building purposes. Hay is scarce, only a small amount being obtainable from the few dry hay sloughs scattered over the township. A rancher who is located in section 25 feeds, as a rule, wool top to his stock, and they seem to prefer it to the slough grasses. There are no lakes or sloughs in the township. Water is procurable from the river and from a few creeks which in hot weather are almost dry. There is no flooded land, except when the Saskatchewan overflows its banks. From observation and inquiry, I should say there are no summer frosts. I did not notice any signs of lignite veins or coal in this township, nor are there any stone quarries. The nearest postoffice is Log Valley, situated in section 34, township 20, range 8, across the river, which makes the transport of mail difficult. The nearest town is Herbert, a small town on the main line of the Canadian Pacific railway, distant forty miles to the south. Should one not care, however, to risk swimming their horses across the river, it is necessary to travel around by The Elbow, thus involving an extra journey of sixty miles. A ferry in this vicinity would be a great boon to the settlers. With the exception of a few jumping deer, we did not notice any game in this township. Several lines of the original survey had to be entirely resurveyed, as many of the mounds were obliterated, this being caused by the nature of the soil causing the banks to cave in. The southern and eastern parts of this township being so rough and broken, it will never be of use for cultivation, but nevertheless forms an ideal ranching country.—*E. W. Hubbell, D.L.S., 1906.*

22. In order to reach this township, we had to travel around by The Elbow and then cross the river by the ferry. From this point a fairly good trail leads to the township, although in places it is difficult to follow as, for some eight miles, it passes through sand hills. The soil throughout is sandy loam, suitable for growing wheat, barley, oats and vegetables, but, owing to its nature, considerable moisture is necessary to guarantee a first-class crop. The surface is open and rolling, but hilly in the northern and western portions, also broken and hilly in the eastern portion, the latter being caused by the huge ravines and gullies which extend into the South Saskatchewan, which flows in a northerly direction through this township. There is no timber of any description, except some poplar and ash in the ravines which adjoin the river. There is also a small quantity of timber on the banks of the river in sections 13, 24 and 25; some of it is suitable for building purposes, but it is being used up rapidly by settlers on adjacent lands. There are a few hay sloughs situated in sections 7, 9, 18 and 20, from which the settlers procure hay for the winter. Besides the river and Sandy lake, there are a few springs in the ravines which run into the river, an especially good one being in sections 12 and 13. Regarding the climate, to the best of my knowledge and belief there are no summer frosts. We did not notice any signs of coal or lignite veins in the neighbourhood of this township. The nearest railway station is Herbert, situated on the main line of the Canadian Pacific railway about forty miles to the south, but in order to reach it one has to cross the river at The Elbow, necessitating a journey of eighty miles or thereabouts. The nearest postoffice is Log Valley, situated in section 24, township 20, range 8, on the other side of the river. There are no stone quarries, but boulders are seen occasionally on the hilltops. We did not observe any traces of minerals. A few antelope and jumping deer were seen, also coyotes and foxes and a few prairie chicken. A few settlers' and hay trails run

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 8—Continued.

through this township, and at the time of survey (July) there were only three or four settlers' houses. However, I believe most, if not all, of the lands open for homesteads are entered for.—*E. W. Hubbell, D.L.S., 1906.*

Ranges 11 and 12.

9 and 10. *East boundaries.*—These townships are all open prairie; for the most part the surface is rolling, but in some places it is quite level. The soil is chiefly clay or sandy loam, with clay subsoil. Most of the land coming under my observation could be rated only as third class, but it is fairly good for general farming or for grazing purposes. The absence of timber and of any apparent source of easily accessible fuel presents serious obstacles to settlement. No building stone or mineral of economic value was observed.—*Geo. Edwards, D.L.S., 1906.*

Range 11.

11. This township is accessible by a good trail from Swiftcurrent. The soil is chiefly clay, with varying proportions of sand or sandy loam, and is suitable for general farming. The surface is generally rolling prairie with no timber whatever. There are no hay areas of any considerable extent. There is one small creek traversing sections 35 and 25, but not with a permanent flow of water. Russell creek crosses the southern part of the township from west to east. The upper part of the creek appears to be fed by springs which afford a continuous supply of excellent water. The water at time of survey had no current farther than section 9, where it was entirely absorbed, and only stagnant pools along the bed of the stream marked its course. Climate is good, summer frosts are evidently unusual, but the average rainfall appears to be light. There is no fuel supply within the township. There are no stone quarries, and no minerals of economic value. Antelope were seen occasionally. A few ducks were the only other kind of game observed.—*Geo. Edwards, D.L.S., 1906.*

12. This township is reached by a good trail from Swiftcurrent. The soil is almost uniformly clay throughout, about two-thirds of the area being well adapted for general farming; the remainder is too rough for cultivation, but suitable for grazing. The surface is entirely open prairie with no timber whatever. There are no hay areas of any considerable extent. The water supply is scant. One creek traverses the township, but it was partially dried up at time of survey and could not be depended on as a permanent source of supply. Climatic conditions are favourable. No summer frosts were observed. The average rainfall seems to be light. There is no fuel supply within the boundaries of the township. There are no stone quarries, and no minerals of economic value. Antelope were seen frequently. No other kinds of game were observed.—*Geo. Edwards, D.L.S., 1906.*

Range 19.

29. The route for reaching this township is along the surveyed trail from Swiftcurrent towards Battleford, and thence westerly to the township. The trail is in good condition. If approaching from the north along the surveyed trail the best route would be to leave it where it crosses Eagle creek, and follow the old cart trail running southwesterly which enters the township in section 36, and crossing the township leaves it in section 18. The soil is generally six to eight inches of black loam on a clay subsoil. The township is suitable for grazing. Sections 1 to 6 are stony, but the remainder of the township is suitable for farming as far as the soil is concerned. The whole of this township is open prairie. There is no timber. There are a few hay marshes, one of considerable size in sections 16 and 21, and another in sections 25

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 19—Continued.

and 36. The hay from these would be of good quality. The supply of water is limited. Strawberry lake enters the township in sections 4 and 5 and affords a permanent supply of fairly good water, but the remainder of the township would have to depend on the water in the large hay marshes before mentioned. The land is not liable to be flooded. There are no water-powers. The general indications point to a climate with comparatively little rainfall in the summer months. There were no summer frosts. There is no supply of fuel in this township. No coal or lignite veins were found. There were no stone quarries or minerals of any kind found in this township. A good many antelope were seen, also ducks.—*Herbert J. Bowman, D.L.S., 1904.*

30. The route for reaching this township is along the surveyed trail from Swiftcurrent towards Battleford, and thence westerly to this township. The trail is in good condition. The whole of this township is open prairie. There is no timber. The growth of grass is sparse, there are very few hay marshes in the township, but there is a large one in sections 20 and 29 and another in section 7, and smaller ones in sections 10 and 16. The hay from the marshes would be good. Water is scarce in this township, but there is a permanent pond in section 4, also a number of sloughs along the north boundary with fresh water. The land is not liable to be flooded. There are no water-powers. The general indications point to a climate with comparatively little rainfall in the summer months. There were no summer frosts. There is no supply of fuel in this township. No coal or lignite veins were found. There were no stone quarries or minerals of any kind found in this township. A few antelope and ducks were seen.—*Herbert J. Bowman, D.L.S., 1904.*

31. The route for reaching this township would be along the surveyed trail from Swiftcurrent towards Battleford, leaving it about opposite the centre of township 30, range 17, and thence northwesterly across township 30, range 18. The trail is good, but light loads would have to be taken across the hilly country after leaving the trail. The whole of the township is clay. The land would be suitable for grazing, and also for farming, as it is thought that when the soil is tilled it would tend to increase the rainfall. The whole of the township is open prairie. There is no timber. The growth of grass on this heavy clay land is sparse and hay marshes are not numerous, but there are a few in the southerly half of the township, viz., in sections 3, 4, 5, 10, 12, 15 and 16. The hay from the marshes would be good. Water is scarce in this township but may be obtained in sloughs, and marshes along the south and east boundaries except after a succession of dry seasons. The land is not liable to be flooded. There are no water-powers. The general indications point to a climate with comparatively little rainfall in the summer months. There were no summer frosts. There is no supply of fuel in this township. No coal or lignite veins were found. There were no stone quarries or minerals of any kind found in this township. Game is scarce.—*Herbert J. Bowman, D.L.S., 1904.*

Range 27

21. The route by which we arrived at the township was a trail running northerly from Maple Creek. In the summer this is a good trail but in the early part of the season there are some places that are difficult to travel through. This township taken as a whole is a fairly good township, there being a great deal of very good land in it, chiefly clay and clay loam. The surface is all open prairie quite destitute of timber, as are also the townships in this district. There are no hay lands or meadows, as the township is very dry. Water is very scarce, there being no ponds or sloughs nor are there any streams. The lack of water would be a drawback to settlers, but I think water can be got by digging wells. The climate appears to be good. There are no

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 27—Continued.

indications of any summer frosts. Fuel of all kinds is entirely wanting, there being no timber of any kind, and no indications of coal in any part of the township. In fact there are no indications of any minerals or stone to be seen anywhere in the township. Game is entirely wanting, as there are no ponds for ducks or wild geese. Taking the township as a whole, a great part of it is available for agricultural purposes for growing wheat, oats and roots.—*Jas. Warren, D.L.S., 1906.*

22. The route by which we arrived at this township was a trail running northerly from Maple Creek. This is a good trail except in spring, at which time there are places difficult to cross. The southerly portion of this township is very good land. The northerly part is not so good, being in many places very sandy, with sand hills and small scrub. The southerly portion would be well adapted for general farming, wheat and root growing, as the soil is quite loamy and good. The surface is open prairie and in places rolling. There is no timber on any part of the township, only a few small clumps of poplar in the northerly part. There are no hay lands. Water is scarce, there being no sloughs or ponds, but from the appearance of the land water could be got by digging. Fuel is entirely wanting, there being no timber and no signs of coal or lignite. There are no quarries, nor are there any loose stones that could be used for building purposes. There are no indications of any minerals of any kind. Game is scarce, as none was seen by us during the survey. Taking the township as a whole, the southerly portion would be well adapted for general farming, as the situation and general lay of the land is quite favourable for such.—*James Warren, D.L.S., 1906.*

Range 28.

21. This township was reached by a trail running northerly from Maple Creek. This is a fairly good trail, especially in the summer season, though early in the spring parts of the trail were very bad and difficult to travel over. This township had fairly good soil in the greater part, though part of the southerly portion is sandy. With this exception the township has a great deal of good land in it, and would be well adapted for wheat and grain growing. The surface is all open prairie, with the exception of a few scrub bushes in some portions. There are no hay lands in any part of the township. Water is very scarce, and where found contains a great deal of alkali in it, rendering it almost unfit for use. There are no streams in any part of the township, and, of course, no waterfalls or mill sites. The climate is good, and there are no indications of summer frosts. There is no fuel available in any part of the township, except a few poplar bluffs in the southwesterly part. There is no coal or lignite to be found in the township, nor are there any stone quarries, and very few loose stone. There are no indications of minerals of any kind. Game is almost unknown; there are no ducks or antelope. Taking the township as a whole, it is better adapted for agricultural purposes than for ranching.—*Jas. Warren, D.L.S., 1906*... .. ..

22. The route by which we arrived at this township was by a trail running northerly from Maple Creek, which, except in a few places, we found very good, the very wet season having made some parts heavy for travelling. The northerly portion of the township is badly broken up by ravines running toward Saskatchewan river. The southern portion is open and undulating prairie, there being no timber of any kind in the township. There are no hay lands and no marshes or sloughs. Water is scarce, there being no streams of any kind. The nearest permanent supply is at the river to the north. There is no fuel in the township, but a little timber can be got in the valley of the river. There are no indications of coal or lignite, nor any stone quarries or minerals of any kind. Game is also scarce, only a few ducks along the river. The southern part of the township would be fairly well adapted for agriculture, but the northerly portion is not available for such but could be used only for grazing along with the adjoining lands.—*James Warren, D.L.S., 1906.*

TOWNSHIPS WEST OF THE THIRD MERIDIAN.

Range 29.

2. I left Medicine Hat on June 21, passing through Cypress hills via the Lodge police post and thence down Lodge creek to the work. The trails at this time of the year were in rather poor condition owing to the heavy rainfall during the end of May and early part of June. There is also a trail from Maple Creek to this township, and the distance is somewhat less than from Medicine Hat, but is reported to be much rougher. Many settlers coming to this locality come via Havre, a station on the Great Northern railway and distant some forty miles from this township, and the trial is said to be fairly good. The soil on the uplands is clay, clay and sand, and clay mixed with stones, and does not appear to be adapted to farming on account of the small rainfall. The soil in the valleys is sandy or clay loam and when irrigated yields most luxuriant crops. I am informed of, and indeed some of the small garden patches that came under my observation showed, the beneficial effects of irrigation producing all kinds of garden vegetables, and a few small fields of oats and hay. The uplands, however, appear to be well adapted for stock grazing purposes, as the herds seen in this locality all bore testimony to the excellent quality of the feed. The surface of the township is gently rolling prairie broken by the valleys of Lodge and Middle creeks. There is no timber in this township, but along the creeks one finds an occasional clump of willow brush. There is no land that could be properly called hay lands, except a very small amount in the valleys, and even here the crop is exceedingly short, although cut by ranchers in place of better. The township is well watered by Middle and Lodge creeks, that flow through it in a southerly direction. These creeks, as is characteristic of prairie streams, rise and fall with great rapidity. When I first reached Middle creek the water was from two and one-half to six feet deep, with a current of four miles per hour, a week later it had fallen to from one to three feet with a current of two and one-half to three miles per hour, and I was credibly informed that both this creek and Lodge Creek ceased to run in August and September. There was always water enough, however, for watering stock. The valley is liable to be flooded to a depth of from one to three feet almost any spring or early summer. Owing to the extreme fluctuations in the volume of water, I do not think these streams would be suitable for developing power of any kind, but the settlers along them are all engaged in putting in irrigation systems on a small scale, and I have no doubt will very greatly increase the value of these bottom lands. After June, there is very little rainfall, usually bright weather but subject to violent winds, indeed there are but few days that are not windy and during July and the end of June much haze and smoke seemed to be in the air, which rendered daylight observing somewhat difficult. For fuel both wood and coal are in use. The wood may be obtained in Cypress hills, consisting of spruce and poplar, but is very rapidly disappearing. Coal is the chief fuel and is at present obtained about ten miles south of this township in the state of Montana, where settlers go and dig it for themselves. It is of the bituminous variety, is largely mixed with shale and other detrital matter and contains considerable sulphur. No veins of coal were seen in this township. No stone quarries were observed. No minerals of economic value were found. Jack-rabbits, chickens, a few ducks, antelope, kit foxes, coyotes, were comparatively numerous, and badgers abound everywhere, but antelope are being rapidly driven back by the advancing settlements. There are three settlers in this township who are all located on Middle creek. All have small herds of cattle from two hundred and fifty to three hundred and fifty each, and each of them is working on an irrigation scheme by means of which he hopes to be able to raise at least all the hay required to winter his herd, and which if successful will tend to increase the value of their holdings very materially. There were other locations along those creeks open at the time of my visit which I have no doubt might be as successfully irrigated as those mentioned and would make this township of some considerable value.—*A. H. Hawkins, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 7.

59. The township is somewhat difficult of access owing to the valley which runs from the northwest corner to the southeast corner and is on an average of 300 feet deep. There is a trail from Keheewin Indian reserve to Moose lake, which crosses the northeast corner of this township and a surveyor's trail which is very rough crossing the township from the southwest corner to the first named trail. The township is fairly heavily timbered with poplar, birch and spruce up to 14 inches diameter, but there is not sufficient timber nor is it of large enough size to warrant a timber reserve. An excellent stream runs from Keheewin lake in the southeast corner to Bangs lake in the northwest corner and there are also a few smaller tributary creeks. The feed along the eastern slope of the valley is excellent and slough hay can be cut in the valley bottom, otherwise there is little feed of any sort. The soil is good, averaging 6 inches black loam and clay subsoil. Moose, caribou and deer are to be found, also fur-bearing animals as bear, mink, coyotes, etc. There are fish in Keheewin lake and Longlake creek but no whitefish. No minerals were observed.—*M. W. Hopkins, D L.S., 1906.*

60. Two excellent trails cross this township, one from Keheewin Indian reserve and the other from Fort Pitt and Onion lake, both joining in section 16 and leading to Cold lake. The township is well supplied with water, by lakes and creeks. Hay is fairly plentiful. The soil is an average of six inches black loam with a clay subsoil. Around Moose lake the soil is sandy. There is ample timber in the township for building and fuel purposes, including poplar, spruce and jackpine. A large part of the township especially in the centre has been burnt, leaving large patches of brulé standing and fallen. The country is well hunted by Moose Lake Indian reserve Indians and game is not plentiful. Moose lake is well stocked with whitefish and there are fish in Bangs lake.—*M. W. Hopkins, D.L.S., 1906.*

Range 8.

59. Two trails cross this township, the one a well beaten trail from St. Paul to Moose lake and Cold lake, the other an old trail (not well travelled) from Fort Pitt to Lac LaBiche. There are many lakes all containing good water. Also two good creeks, one running through sections 26, 27, 34 and 35, the other through sections 6, 5 and 4; the former is fed by springs and probably never dries up, the latter at time of survey had only a few pools of water. The soil is good, averaging six inches black loam and clay subsoil. The township is somewhat stony in parts, especially on Chickenhill in sections 33 and 34. Timber for fuel is fairly plentiful, especially in the eastern half of the township. Good upland and slough hay can be cut. Moose, caribou, bear and other fur-bearing animals are found. Fish are found in Chickenhill lake, but not whitefish.—*M. W. Hopkins, D.L.S., 1906.*

60. The whole township is well adapted to farming; as the land is level and undulating with the exception of sections 1, 2, 11, 12, 14 and 13, which are broken by small ravines in places, but are still first-class farming lands. There is fair timber in the south of the township, spruce, poplar and some ridges of jackpine, but the northern part of the township is only lightly timbered with poplar and willow brush. An excellent creek, Yelling creek, runs from west to east clear across the township and joins the larger Longlake creek in section 12. Yelling creek has its source in a spring in township 60, range 10, and is said never to run dry. There are not many sloughs and only one lake in section 25. The soil varies from two inches to six or nine inches of black loam throughout the township; all the subsoil is clay. Moose lake trail, which is a well travelled trail, crosses the southeast corner of the township and wagons can traverse most of the township with little difficulty. There seemed to be rather a scarcity of game, but the trails and tracks show that at times game com-

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 8—Continued.

prising bear, moose, caribou and deer are fairly plentiful. No fish were observed. No traces of gold, &c., were observed, nor coal nor lignite.—*M. W. Hopkins, D.L.S., 1906.*

Range 9.

59. The whole township is of excellent farming character and is well supplied with timber, water and hay. The soil is of a rich black loam from two to twelve inches in depth with clay subsoil. The township is well supplied with water by lakes, sloughs and creeks. Vincent lake is surrounded by timber suitable for fuel or building purposes, with the exception of the east side. Upland and slough hay can be cut in ample quantities. An excellent trail traverses the townships from the southeast to northwest corner. Duck and chicken are plentiful and Vincent lake is full of fish such as whitefish. No signs of coal, lignite or minerals of any kind were observed. The township is fairly well settled already.—*M. W. Hopkins, D.L.S., 1906.*

Range 10.

59. A good trail from St. Paul de Metis crosses this township and there are several other trails branching from this main trail. The soil is good, averaging six inches black loam with clay subsoil. Water is plentifully supplied by lakes, sloughs and creeks. Hay, both upland and slough hay, can be cut in abundance. There is not very much building or fuel timber in the township, but plenty can be cut in a radius of six miles. The northern part of the township is well wooded. Duck and chicken are plentiful and there are plenty of jackfish and perch in Vincent lake. No traces of minerals were observed. Generally the township is most suitable for mixed farming.—*M. W. Hopkins, D.L.S., 1906.*

60. The old Lac LaBiche and Ft. Pitt trail crosses the northeast corner of the township and a rough trail has been cut from section 2 to section 23 and thence across to the Lac LaBiche trail in section 25. There is also a hunters' pack trail across the township to Muskeg lake. The township is very thickly wooded with poplar, spruce and some tamarack and birch; the undergrowth also is very dense. There are several lakes, all containing good water. The northeast corner of the township contains some good hay sloughs and there are some in sections 1 and 12, otherwise feed is scarce. The average soil is 6 inches black loam with clay subsoil. No traces of lignite, coal or minerals were observed. Moose and caribou are to be found, also bear, mink, fox, &c., in fair quantities. Fish are fairly plentiful in Island lake (now called Mann lake)—*M. W. Hopkins, D.L.S., 1906.*

Range 12.

3. The route to this township is the same as that to township 3, range 13, by trail south to Kip coulée; thence along the north side of the coulée to the east end of King lake; thence southerly over the bare rolling prairie. The soil is a sandy brown loam about eighteen inches in depth generally. It would make fair farming land but for the drouth. The surface is quite rolling and in fact there are some ravines in the southeastern part of the township and a high ridge or two. It is all prairie without the least scrub or timber on it. There are one or two lake-bottoms in it. Hay is not plentiful at all but a little can be obtained almost anywhere in the township. It is of good quality, there being no rank growth in any of these townships. Water was found only in a small ravine and there was very little in it. It seemed to be a spring but was nearly dried up. The water was not tasted as we got our water in barrels from Milk river, a haul of nine miles, but the water was good and fresh. The land is not liable to be flooded. The climate was usually fine and warm and dry but at times very strong, cool winds were experienced. No summer frosts were noticed. There was no

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 12—Continued.

fuel in the township but coal can be had at Taber. There were no stone quarries or minerals. The only game was antelope. All of this country makes fairly good grazing land, but the scarcity of water is a drawback.—*W. G. McFarlane, D.L.S., 1906.*

Range 13.

1. The best route for reaching this township is by way of Coutts, a station on the International boundary, on the Alberta Railway and Coal Company's railway, and from thence a good trail leads directly through the township. The soil varies from clay to sand and gravel, but is chiefly three to eight inches of loam with a clay subsoil. It produces a fair crop of grass and with irrigation would doubtless yield abundantly but under the present conditions it is adapted only for cattle-raising. Several settlers whom I met and whose crops I saw were not enthusiastic about the farming possibilities. The surface is rolling prairie cut by several deep coulées running from Sweetgrass hills to Milk river. In some of these we found poplar and willow bush and a few large cottonwood trees. The quantity of timber is not sufficient to make it of any economic value, except to the settler. There are no hay lands in this township. The principal supply of water is from Milk river flowing across the northeasterly corner of the township. The supply is apparently sufficient for the present demands but I was credibly informed that in very dry seasons it ceases to run entirely. The valley is liable to be flooded during the spring freshets. The river would average about three chains in width and from three inches to three feet in depth and the current from two to three and one-half miles per hour depending upon the season. Several good springs were found along the coulées and are used by the cattle as watering places. There are no available water-powers in this township. The climate is dry and warm during the summer months, but is subject to summer frosts. The nights are always cool, and frequent violent winds sweep over the entire country. The principal fuel is coal, and indications were observed on the north boundaries of sections 24 and 23 where these lines cut the coulées. Shale and what appeared to be weathered coal was observed in several places along the coulées. There is a most bountiful supply of stone in this township and easily accessible at any place along Milk river, or on Police or Rocky coulées. The supply is practically unlimited and is used by settlers for foundations, &c., and appears to be a very good building material. No minerals of economic value were observed although a prospector showed me what he called petroleum, but declined to point out the position of his location. Chicken, a few ducks and rabbits, coyotes and kit-foxes were all the varieties of game seen in this township. There are some seven settlers but all devote themselves to cattle or horses and no farming of any account is attempted.—*A. H. Hawkins, D.L.S., 1906.*

3. The route followed to this township was by trail south from Furman's ranch to Kip coulée; thence along the north side of the coulée by trail to the east end of King's lake; thence southeasterly by south over the prairie. The trail was hard and dry, but we could not cross the coulée west of King's lake as the water from the irrigation canals make the bottom soft and miry. The soil is a brown sandy loam about eighteen inches in depth in general, but there are a few lake-bottoms which are very heavy clay. It would make fair farming land. The surface is rolling prairie with several fairly large dry lake-bottoms and a few ridges. There is no scrub or timber in it. The lake-bottoms are near the eastern side. Hay is scarce, but a little of good quality can be found in any part of the township. There was no water in the township, but the lake-bottoms showed signs of alkali. The climate was usually mild, dry and clear, but sometimes cloudy and very cool with very high winds almost hurricanes. No summer frosts were noticed. Fuel is not to be found in the township, but coal can be had at Taber. There are no stone quarries or minerals in the township. The

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 13—Continued.

only game was antelope, but ducks and geese were plentiful in Kip coulée. This township is more rolling than those to the north, and some of the ridges are somewhat gravelly and stony. There are also quite a number of fairly large lake-bottoms which show a very heavy clay soil.—*W. G. McFarlane, D.L.S., 1906.*

6. To reach this township one can drive anywhere over the prairie with the exception of the northeast corner where Chin coulée just crosses the corner, but side coulées cut it up somewhat. There are no trails in the township. The soil is usually a brown loam eighteen inches deep, but it is so dry that it would not produce good crops unless it were irrigated. It is a little stony and gravelly near Chin coulée. It is fairly good for grazing. The surface is gently rolling prairie without a sign of scrub or timber, but the northeast corner of the township is rough as it is cut up by side coulées running out from Chin coulée. Hay is very scarce, but a little of good quality can be had here and there over the whole township. There is no water whatever in this township, but there is not much sign of alkali except in Chin coulée, where it can be noticed. The climate was fine, warm and dry, but subject to high winds. No summer frosts were noticed. There is no fuel in the township, but coal can be had at Taber. There are no stone quarries or minerals. The only game seen was antelope. In each of these townships there are small depressions or hollows which hold water for a short time after a heavy rain, but water is scarce here.—*W. G. McFarlane, D.L.S., 1906.*

7. There are no trails of any importance in this township, but one can drive anywhere over it except down the banks of Chin coulée, which are high and steep. The surface is almost level prairie except along Chin coulée, where numerous side coulées cut the country up. The soil is a good loam, but is very dry. In the coulée it is heavier, but the whole township would need to be irrigated before it would be good farming land. There is neither scrub nor timber anywhere in the township. Hay is very scarce all over the township, especially down the coulée, but a little of good quality can be cut on the high land. There is no water in the township. The climate was bright and warm and dry, but subject to strong winds. No summer frosts were noticed. There is no fuel in the township, but coal may be had at Taber. There are no stone quarries or minerals in the township. The only kind of game seen was antelope. This township is badly cut up by coulées as Chin coulée runs across it and there are numerous side coulées, but the soil is rather better than in the township to the west of it.—*W. G. McFarlane, D.L S., 1906.*

65. The township is gently rolling and much cut up by marshy lakes. Hay is abundant. The township is timbered with poplar and scattered spruce. The soil is clay loam.—*A. W. Ponton, D.L.S., 1906.*

66. Beaver lake covers a large area. Much land suitable for settlement was observed adjacent to the lake shore. The township is timbered with poplar of good size, and scattered spruce. The surface is rolling. Whitefish is abundant. An Indian settlement is located chiefly in range 13, but no reserve has yet been allotted to these Indians.—*A. W. Ponton, D.L.S., 1906.*

67. Lac LaBiche covers a large area. The country is high, rolling and well drained. It is heavily wooded with poplar, and the soil is clay loam. Fishing offers opportunities to settlers, as whitefish are plentiful in the lake.—*A. W. Ponton, D.L.S., 1906.*

68. Lac LaBiche and Square lakes cover a large area. Good land occurs between these lakes, and also adjacent to Square lake. Square lake is a fine body of water, and whitefish are obtainable in it. There is also much good land suitable for settle-

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 13—Continued.

ment between Grand bay of Lac LaBiche, in township 67, range 13, and the northern end of the lake, in township 68, and is accessible by trail from the Hudson's Bay post. The country is generally wooded with poplar, but fairly open ground can be found adjacent to the lake.—*A. W. Ponton, D.L.S., 1906.*

Range 14.

6. The route followed to this township was due south from Furman's ranch. This trail runs down to Kip coulée to other ranches. There is another trail running towards Furman's ranch from hay-meadows in the southwest part of the township but one can drive anywhere over the township. The soil is a brown loam about eighteen inches in depth and would make good farming land if irrigated. It is now fair grazing land. The surface is level or gently rolling prairie without a sign of scrub or timber on it. Hay is rather more plentiful in the southwestern part of this township than in the others. It is of good quality too, but is not abundant. The chief reason for the great scarcity this year seems to be the drouth. Consequently there is only short grass for the cattle and horses, so they roam farther and pick the grass off short. There was no water to be found in the township and we had no rain. The climate was fine, warm and dry, but strong winds were frequent. There is no fuel in the township, but coal can be had at Taber. There are no minerals or stone quarries. The only game seen was antelope and jack-rabbits. This township would make excellent farming land if irrigated but the scarcity of water is against it at present.—*W. G. McFarlane, D.L.S., 1906.*

7. This part of the country is all open prairie, but Chin coulée runs right across this township. The coulée is over two hundred feet in depth and in places its banks are steep, otherwise one could drive all over it. There is a trail, however, from Gardner's ranch, in township 8, range 14, to Furman's ranch in this township in the coulée in section 14. The soil is usually a sandy loam for a depth of nearly eighteen inches, but along the bottom of the coulée there is a heavy clay with boulders, while to the north of it there is mostly sand near the coulée. It is very dry, otherwise it would be very good agricultural land. If it is irrigated it should produce good crops. The surface is all prairie, usually gently rolling, except along the Chin coulée, where numerous side coulées cut it up a great deal, especially to the south. There is no timber, but two trees, willow, are growing in the coulée opposite Furman's ranch. The water is slightly alkaline, but is found only at Furman's ranch in his well, which has not gone dry but gets low at times, when too much stock is watered out of it. Part of the bottom of the coulée may be flooded at times, as some of it was once the bottom of a shallow lake. Hay is scarce but of good quality in the south part. Needless to say there are no water-powers. The weather was fine, dry and warm, but there was usually a breeze and sometimes it was very windy. No summer frosts were noticed. No fuel is to be found in the township, but coal can be had at Taber, which is within easy reach. There are no stone quarries or minerals in the township. The only game seen was antelope. This township is probably more cut up by coulées than any of those around it, and the soil is lighter close along the north side of Chin coulée, but the south side has some good land.—*W. G. McFarlane, D.L.S., 1906.*

8. The best route to reach this township is by the trail from Taber direct to Gardner's ranch although one can drive anywhere over this country as it is all open, level or gently rolling prairie. The soil is usually about eighteen inches of sandy loam. There are a few stones toward the west side of the township. It would make good farming land if irrigated. The surface is gently rolling bare prairie without a sign of scrub or timber on it. Hay is scarce but of good quality. There are a few

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 14—Continued.

hay meadows scattered over the township but they are mere hollows. The water is fairly good with but little alkali in it. It was only found at Gardner's ranch where there is an excellent spring which never fails, and also a small pond. There are no water-powers. The climate was fine, warm and dry, but subject to strong winds. No summer frosts were noticed. There is no fuel in the township, but coal can be had at Taber. There are no stone quarries or minerals. The only game seen was antelope. This township is rather more rolling than those just west of it, otherwise it resembles them closely.—*W. G. McFarlane, D.L.S., 1906.*

35. The soil (of what land there is) is first-class undulating prairie, black loam up to fourteen inches deep; but about two-thirds of the township is covered by the waters of Sullivan lake, which is of a light clay colour, alkaline and of little use. We were fortunate in finding a shallow slough of fresh water on section 29, on the peninsula, and another on section 24, on the east side of the lake, but none on the islands. There is a small bluff of poplar and willow along the lake shore on the fraction of the northwest quarter of section 27, west of the straits. This, with a few clumps of willow on the islands, is all the timber in the township. There is a coal seam along the lake shore on sections 29 and 30. I could not tell how thick it was on account of the water being only about eighteen inches below the top of the seam. Granite and sandstone boulders all along the shore of the lake, some of them very large, were all the stone we noticed. No other minerals of economic value were found. There is a great quantity of upland hay, but no regular meadows. There are no water-powers. No frosts occurred while I was there (July). We found quite a quantity of gooseberries and some raspberries on the islands. There are some poplar bluffs that would serve for fuel in the next township east of this one, but none fit for building purposes. Waterfowl and prairie chicken are plentiful, but we noticed no large game. This township can be reached from Stettler by a fair road around the north end of the north arm of Sullivan lake. If good water could be got by sinking wells, what land there is in this township, would make first-class grain farms, I believe.—*A. McFee, D.L.S., 1906.*

68. The country is rolling with clay loam soil. Owl river flows south through the eastern portion to join Lac LaBiche. Extensive hay lands occur at the mouth of this river.—*A. W. Ponton, D.L.S., 1906.*

Range 15.

6. The route followed to this township was northerly across the prairie to King lake; thence westerly up Kip coulée to this township along a trail. It is a good dry road, but one could not cross the coulée with a load where there is water. The soil is a brown loam about eighteen inches in depth and would make good farm land if irrigated. It is only a grazing country now. The surface is usually a gently rolling prairie, but the south side is considerably broken up by Kip coulée. It has no scrub or timber on it whatever. Hay is scarce, but a little of good quality could be had almost anywhere except close to the coulée, where the grass was eaten off short. The only water was that running down the coulée. It is a fine stream of fresh water, about twenty-five feet wide and from two to five feet deep, with a current of one or two miles an hour. There is no water-power. The climate was cool except in the middle of the day, but usually bright. High winds were very frequent. Light frosts were noticed. Rain was scarce. No fuel was found, but coal can be had at Taber. The only game found was antelope and ducks. The water from the irrigation ditches is a great help here, especially for grazing.—*W. G. McFarlane, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 15—Continued.

7. As the country is all open prairie one can travel anywhere over it with wagons, except at Chin coulée where the banks are steep and high, and quite a number of side coulées are found. Some of these side coulées run down to a narrow stony gorge, while others are broader and flat at the bottom, giving a good road in and out of the coulée. The road used by us was in section 30, just north of Mr. Robertson's sheep ranch. The soil is generally a sandy loam. Here and there ,however, some gravel is found, and in some places the surface is quite stony. The greater part of the township, especially back a short distance from the coulée, is, however, very good farming land, but is very dry. Near the coulée quite a number of small ravines or side coulées run into the banks, some for quite a distance, cutting the sections up rather badly. The surface is all prairie. There is no timber or wood near, but some very small scrub is found in the side coulées, though too small to be of any use. Hay is scarce, but some can be found on the high land in slight hollows. It is good, as it grows on dry land, there being no sloughs in the township, except one at Robertson's ranch in section 19, which is really more of an artificial reservoir. The water is fairly good but slightly alkaline. It was only found at the ranch. Considerable alkali is seen down the coulée but not very much on the high land. There is no danger of flood in this township as there are no streams, although water may soon be running down the coulée towards the east from the irrigation canals and ditches. There are no water-powers. The climate was very hot during part of August, until we had a three days' steady rain, when it became fairly cool. No summer frosts were noticed. High winds are often a considerable inconvenience in running lines. No fuel was found in the township, but plenty of coal may be had at the mines at Taber. There were no stone quarries or minerals found in the township. Antelope was the only game seen. In general all this country is one monotonous sameness, gently rolling bare prairie with from twelve to eighteen inches of brown sandy clay loam, not a slough to be found, no hills except along Chin coulée and the side coulées running into it. This is the only break in the surface, but it is a decided one, as its banks are invariably over two hundred feet high, steep and also often stony. Very few stones are found when one gets a short distance away from the coulées.—*W. G. McFarlane, D.L.S., 1906.*

8. As the whole township is bare, almost level prairie, one can travel anywhere over it with wagons. There are only two well-beaten trails crossing it from southeast to northwest towards Taber. The soil is a brown sandy clay loam from twelve to eighteen inches in depth, with a heavy clay subsoil. It is very dry, not even a sign of moisture at the bottom of the pits. Were it not so extremely dry it would be first-class farming land, but unless irrigated it will not likely produce a good crop year after year. The surface is all gently rolling or almost level, bare open prairie, without a sign of scrub of any kind and very few stones. Hay is scarce, but some can be found in hollows. It is of good quality, as there is no water, and it is all upland hay. Water was not to be found anywhere in the township either in sloughs or springs. Slight traces of alkali were seen. There are no water-powers. The climate was quite hot for part of August, but turned cooler after we had a three days' rain. No summer frosts were noticed. High winds were frequent. There is no fuel in the township, but coal can be had at Taber. There are no stone quarries or minerals of any kind. Antelope was the only game found. When this township is irrigated it will probably make excellent farming land.—*W. G. McFarlane, D.L.S., 1906.*

35. The soil is from four to five inches of clay loam with very hard clay subsoil. The surface of the northwest part of the township is rather rough and hilly, with potholes. Most of the remainder is rolling, the eastern part near Sullivan lake being gently undulating. The lake takes up quite a portion of the northeast part of the township.

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 15—Continued.

There is a long narrow lake of clay-coloured and alkaline water that extends north and south in sections 20, 29 and 32. There is (in high water) a fair sized creek of good fresh water that runs through sections 32, 28, 21, 22, and empties into Sullivan lake, in the southwest quarter of section 23; but which goes dry except for deep holes some of them ten feet deep. There is no timber and no minerals of any value. The only stone noticed was sandstone and granite boulders. There are no hay meadows of any size, but upland hay can be cut almost anywhere in the township. There are no water-powers. Waterfowl is plentiful, also prairie chicken. We saw a few antelope. No frosts were noticed. Fuel can be had about seven miles north, there being coal on the northwest arm of Sullivan lake. There is a fair wagon road to this locality from Stettler. The banks of Sullivan lake are low and the water is alkaline, clay-coloured and no good. Mr. Leithead has a small house, stables (or sheds) and a pasture fenced on the northwest quarter of section 19. There is a good spring on it. The township as a rule is suitable for mixed farming or stock-raising. Mr. Leithead had a large herd of cattle in this vicinity. The climate seems good.—*A. McFee, D.L.S., 1906.*

68. Lac LaBiche lies immediately south of the line. On the north side the country is generally spruce swamp. Lac LaBiche river leaves the lake in this range. The country is unfit for settlement.—*A. W. Ponton, D.L.S., 1906.*

Range 16.

6. The route followed was by the trail up Kip coulée. There was also a trail along the north side of the coulée running toward Lethbridge. The soil is a brown loam about eighteen inches deep, but there is some heavy clay in places and considerable stone along the sides of the coulée. It will make good farm land when irrigated but is fair grazing country now. The surface is gently rolling prairie along the north of the township, but is somewhat rough near Kip coulée, especially to the south side where rocks show out along the bank and in places the bank is quite steep. The coulée runs right across the township. There is no timber or scrub of any kind. Hay is scarce, but a little could be cut on the high land. The only water was the stream in Kip coulée, which was fresh and good. The stream would be about twenty-five feet wide, from two to five feet deep and current about two miles an hour. There is no water-power. The climate was cool with slight showers and rather cloudy. Strong winds were of very frequent occurrence. Frosts in the morning were sometimes noticed. Some small coal seams were found along the south bank of the coulée. The coal was a soft bituminous of fair quality. Coal could also be had at Taber. There were no stone quarries, but some large soft sandstones were seen in layers, but it was of poor quality. No minerals other than coal were found. The only game was antelope, ducks and jack-rabbits. The fresh water in the coulée makes this township of considerable value for grazing purposes.—*W. G. McFarlane, D.L.S., 1906.*

7. The route followed was due south by trail from Taber to Garrick's ranch in Chin coulée. The soil is good, except in places down the coulée, but is rather lighter than to the north and indeed too dry, but will make good farming land when irrigated. There is nothing but bare prairie without a sign of scrub, except in the coulée, where there are a few sticks one inch in diameter. Hay is very scarce, but there is a little in the hollows and it is good. There is no water except in Chin coulée, at Garrick's ranch in wells, a slough at Robertson's ranch in sectoin 25, and a small spring up in a side coulée in section 34. The water is somewhat alkali. There is no water-power. No summer frosts were noticed. Coal can be had in abundance at Taber mines. No stone quarries were found. No minerals were found. The only game was antelope. The sides of Chin coulée are usually very steep and high and considerable

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 16—Continued.

rock crops out on the ridges. There had been large shallow lakes in the coulée, but they are now dried up.—*W. G. McFarlane, D.L.S., 1906.*

8. This township lies due south of Taber about five miles. There is a very good trail into it. The soil is a brown sandy loam about one foot in depth over the whole township with a heavy brown clay subsoil. It would be excellent farming land if well watered. The surface is level or very gently rolling without a sign of any scrub whatever. There is no timber within miles of it. Hay is very scarce. There are no hay sloughs and the upland hay was very short. Water is not to be found anywhere at the surface in the township, but there is a good well just to the north of it. There are some hollows that would hold water for some time but they were all dry and hard. Needless to say there is no water-power. The climate was very hot in August, but is subject to cool spells with sudden showers. Rain was not plentiful, but we had one storm which lasted steadily for three days. There is no fuel at the surface but there may be coal below it. Very little stone is to be seen. There are no minerals. A few antelope were the only game seen there. This township will make good farming land if irrigated but will not be sure of a crop on account of the drouth.—*W. G. McFarlane, D.L.S., 1906.*

35. There is a good wagon road from Stettler to this section of the country. The soil of this township is generally good, but is very hilly with numerous sloughs and pot-holes fringed with willow and small poplar. There is no timber worth speaking of. Hay can be had around most any of those sloughs or pot-holes. There is a spring on the southwest quarter of section 4 and a small lake. There are also two lakes on section 3 and one on sections 9 and 10. The water is all fresh. There are no water-powers. No frost was noticed. The climate is good. Fuel can be found without much trouble, coal at the northwest arm of Sullivan lake, about ten miles northeast, and wood about the same distance north. The only stone I noticed was granite and sandstone boulders on the ridges and around the lakes. I saw no minerals. Game, such as geese, ducks, cranes and prairie chicken is plentiful. I saw six antelope. Although the township as a rule is rather rough I consider it one of the best in this part of the country for stock-raising and mixed farming. There are no creeks or streams, but any number of deep ponds, nearly all of these fringed with tall willow which makes good shelter for stock. There is also grass in abundance, even on top of the hills. There are no squatters in the township.—*A. McFee, D.L.S., 1906.*

68. The country is rolling and timbered with good sized poplar. The soil is clay loam. Much land is fit for settlement.—*A. W. Ponton, D.L.S., 1906.*

Range 17.

6 and 7. The best route for reaching these townships is from Stirling, a station on the Alberta railway and St. Mary River railway, from which point trails lead to all parts of these townships. At the time of my visit the trail was in good condition and is said to be generally so. The soil generally is clay loam with a clay subsoil, very hard in places, and from the luxurious crop of grass found all over would appear to be fairly good agricultural land, although the small deposition of moisture in this locality might probably be a drawback to farming. The grazing, however, is excellent over both townships. The surface is generally rolling prairie except where cut by the Etzikom and Chin coulées, which range from one hundred and fifty to two hundred feet in depth through these townships. There is neither timber nor scrub in either township. The only water found was in Etzikom coulée, which is said to be the overflow from irrigation ditches, and will doubtless be utilized as the systems are extended. At present the stream is from eighteen inches to five feet deep and

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 17—Continued.

twenty to sixty links wide, with a current of from one to two miles per hour. The water is fresh, but carries large quantities of detrital matter. The valley is not liable to be flooded to any extent. There are no water-powers. A few springs along Chin coulée provide water for cattle grazing in that vicinity. There are no indications of summer frosts. The climate is said to be very equable but subject at all times to violent winds. I saw no fuel in these townships, but was informed that there were veins of lignite on Etzikom coulée in township 6, range 16. At present fuel must be procured from the nearest railway station. No stone quarries were seen. No minerals of economic value were found in these townships. Ducks, geese, a few chickens, foxes and coyotes were the only varieties of game seen.—*A. H. Hawkins, D.L.S., 1906.*

64. What good land occurs in this township is very much cut up by muskegs and swamps; the surface is rolling and covered with poplar, birch, and in places spruce and tamarack. In sections 32 and 31 there is valuable spruce timber from eight to twenty-four inches in diameter surrounding a long narrow lake and extending some distance north and south of the line. There are no hay meadows or tracts of even partially open land in this township.—*R. W. Cautley, D.L.S., 1906.*

Ranges 17 to 20.

68. The country is almost entirely spruce and tamarack swamp. The timber is small and recent fires have destroyed large areas of it. The country generally has no present value. To the north, however, Lac LaBiche river flows west to Athabaska river, and along its banks good land extends back for a quarter of a mile. The river is only navigable for small boats during exceptionally high water; at other seasons shallow rapids are frequent. A trail from Lac LaBiche makes this land accessible. Athabaska river crosses through the west portion of range 20.—*A. W. Ponton, D.L.S., 1906.*

Range 18.

28. This township may be reached by either of two good trails from Calgary or Stettler. The soil other than in the ravines, canyons and river flats, is first class from twelve to eighteen inches of clay loam on chocolate-coloured clay, with clay subsoil, while in the ravines, canyons and river flats it is clay, growing very little or no vegetation. The surface is generally rolling with deep ravines and canyons running from every direction towards Willow creek, which creek (from marks along its banks) had from four to six feet of water in it at times. However, I would judge it to be dry the most of the year. There is only a little alkaline water in holes at present that looks like lye. Red Deer river runs through a canyon about four hundred feet deep with a valley about half a mile in width running into the township at the northwest corner of section 6 and running out a few chains east of the centre of the south boundary of 6, cutting the section up badly. Sections 4, 5, 8 and 9 are very hilly with some pot-holes, with good soil. Fuel may be got along the river banks and in some of the ravines. Although I did not come across any coal seams I noticed frequently that coal had been washed down the river and gulches. There seems to be any quantity of stone along the cutbanks in the canyons and river, mostly sandstone and some granite. I saw no other minerals. Game birds such as geese, ducks, crane, prairie chicken, plover, &c., are plentiful, and a few deer are to be found in the gulches. There is no timber in this township except along the river and some of the ravines, where some black poplar up to sixteen inches in diameter and some brush can be found. I noticed no frost. I consider it a high, dry country and suitable for grain raising or mixed farming. There are a good many stockmen (or ranchers) in

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 18—Continued.

this section of the country, the grass being good, and they have wire fences running in all directions through the prairie. Willow creek canyon runs southwesterly across the township from section 24 and joins the Red Deer canyon in section 7. It is impossible to cross this creek (in this township) with wagons, but it can be got round in range 19 or across in range 17. There are no water-powers.—*A. McFee, D.L.S., 1906.*

64.—*North outline.*—Sections 36 and 35 in this township contain patches of heavy spruce timber surrounding some lakes which occur in them, but together with section 34, are unfit for settlement owing to the rough broken nature of the surface. In these sections there is also a good deal of heavy jackpine. A narrow lake, from five to six miles in length and varying from one mile to half a mile in width, occurs in section 34, which lies almost due north and south, and is surrounded by low broken hills from 40 to 120 feet high. Sections 33, 32 and 31 contain some second class agricultural land having a rolling surface and covered by second growth poplar and heavy brulé. A small creek, flowing north, crosses the line in section 33 and flows through an old beaver meadow in section 4 of about forty acres; this meadow bears a luxuriant growth of wild hay and may extend much farther than it appeared to do from the line.—*R. W. Cautley, D.L.S., 1907.*

Range 19.

64. *North outline.*—Section 36 is covered with dense poplar, birch and spruce woods from four to eight inches in diameter, the remaining sections being covered with heavy spruce brulé and scrub, except where patches of muskeg filled with green spruce and tamarack occur. The surface is rolling and in sections 33 and 34 is higher than any of the country for miles around, being about 140 feet higher than the ground level. There is a good creek in section 35 flowing north, and a large lake, which I have been told is called Skeleton lake, and which appears to be five or six miles long in a southwesterly and northeasterly direction, and one or two miles wide, lies one or two miles to the north of sections 33, 32 and 31. Rated as agricultural land this township falls in the second class.—*R. W. Coutley, D.L.S., 1907.*

Range 20.

51. This township was at one time part of a timber reserve, but fires have destroyed the timber and it is now covered with thick scrub, and in places, scrub with a heavy windfall. The east part of the township is rolling ; the west is level. There are a number of hay sloughs and a number of large lakes. I found a number of squatters in the township, some of them having been there for fifteen years. Cattle-ranching is their principal occupation. They say that the reason for not farming is, that they are afraid that the government might force them to leave.—*G. J. Lonergan, D.L.S., 1906.*

59. We followed the Victoria trail to the intersection of an Indian pack-trail near the north boundary of section 31, township 58, range 19. Then we followed this pack-trail to section 20 township 59, range 20. The soil is a black loam and clay subsoil, suitable for farming purposes. The surface is level and covered with thick poplar and willow. There is no timber. There are no hay lands. Namepi river flows through the southwestern part of the township. The water in the sloughs is fresh. There are no water-powers. The climate was cold and wet at time of survey (July and August) with no summer frosts. The fuel is dry poplar in abundance. No coal was found. No stone quarries were observed. There are no minerals. The game is moose, deer and ducks.—*J. C. Baker, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 20—Continued.

64. *North outline.*—This township is covered with small isolated patches of heavy timber surrounded by brule, and is well adapted for mixed farming. The surface is gently rolling and much of it would be easy to clear. There are two good creeks, one in section 35 and the other in section 33, both flowing north and both permanent, while there is a lake one and one-half miles long in section 31. A large lake which I have been told is called Skeleton lake and which appears to be five or six miles long in a southwesterly and northeasterly direction and one or two miles wide, lies about one mile to the north of sections 35 and 36.—*R. W. Cautley, D.L.S., 1907.*

Range 21.

58. We reached this township by following the Victoria trail as far as the north boundary of township 57, range 20; then by following the boundary west to township 57, range 21 we cut a trail to the northeast corner of section 16. The soil is principally black loam with clay subsoil. When cleared it will be suitable for farming. This township is level and covered with thick willow and poplar. There is no timber. There is no hay land in this township. The water in lake No. 1 is alkaline, but the water in the sloughs is fresh. There are no creeks. At the time of survey, the sloughs were full of water. There is no water-power. The weather was cold and wet during the time of survey (June and July). No summer frosts occur. Plenty of dry poplar may be had anywhere in this township for fuel. No coal was found. No stone quarries or minerals were noticed. Ducks, moose, deer and skunks were seen.—*J. C. Baker, D.L.S., 1906.*

64. *North outline.*—This township is covered for the most part with thick second growth poplar and grey willow, small and easily cleared, with isolated patches of dry spruce or green tamarack from four to twelve inches diameter, and is well suited to the needs of settlers who desire to go in for mixed farming, being near to Athabaska Landing and having egress thereto by a very fair wagon trail which crosses the line at the northeast corner of section 32. The surface is gently rolling and the soil good, much of it being in the first class. A creek, which affords a permanent supply of water, flows in a northeasterly direction across the north boundary of section 34, and two tributaries of another creek flow north across section 32, while there is a lake of about three hundred acres in extent, and surrounded by hay marshes across the north boundary of section 36.—*R. W. Cautley, D.L.S., 1907.*

Ranges 21 and 22.

68. The country is covered with much spruce swamp. The timber is generally small and of little commercial value. Areas occur which are slightly elevated above the swamp lands, but as a whole it is unfit for settlement.—*A. W. Ponton, D.L.S., 1906.*

Range 22.

11. This township can be reached from Lethbridge by a trail which passes through it, leading from Lethbridge to Bow river. The trail is in good condition and can be travelled at any season of the year. The soil of this township varies from a sandy loam to a stiff clay, though through some of the interior parts there are coarse gravel ridges. This township up to the present has been used for grazing. The soil, however, would be suitable for grain growing, if the season were at all favourable, but as a rule it has been too dry for farming. Settlers are coming in and the land is being cultivated for grain growing. The surface of this township is open, rolling prairie. No timber whatever exists on it. Upland hay can be cut from almost any part of the

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 22—Continued.

township and marsh hay can be cut about Keho lake. At the time of this present survey (May and June) there was plenty of surface water in the township owing to the excessive spring rains. A small creek was crossed running southeasterly out of section 1. Keho lake was swollen to several times its ordinary size, flooding nearly all of section 31 and parts of sections 30 and 32. Some of the farmers have dug wells, and obtained water at from thirty feet to one hundred feet. This water can be used but is more or less alkaline. Keho lake water is strongly alkaline. The only fuel is coal and is freighted in from the Lethbridge mines. One settler stated that in digging a well on section 8 he went through several small veins of coal. Coal crops out of the surface on section 18; this coal has been used by some of the settlers, but so far is not of a very good quality, as it weathers very easily on being exposed to the air. No doubt better quality would be found by going deeper into the seam. The climate is dry and no summer frosts were reported. No timber exists in this township, no water-powers, no stone quarries and no minerals except coal, as mentioned above. No game was seen.—*Lennox T. Bray, D.L.S., 1906.*

64. *North outline.*—This township is covered for the most part with poplar and willow scrub, with occasional patches of muskeg filled with spruce and tamarack from 4 to 8 inches in diameter. The surface is a high rolling plateau 250 feet above Tawatinaw river, which crosses the north boundary of section 31, in a northerly direction. A creek crosses the north boundary of section 34, and a tributary of the same creek crosses the north boundary of section 35, both flowing in a northerly direction. The Athabaska Landing wagon road and Government telegraph line cross the north boundary of section 31. Rated as agricultural land, this township is of the first and second class.—*R. W. Cautley, D.L.S., 1907.*

65. This township has been subdivided, and there are some settlers already established in parts of it who seem to be doing very well. One of them, Mr. William F. Smith, keeps a large stopping place on the southwest corner of section 6, and as an instance of the amount of travel which takes place over this road, it may be of interest to state that it is no uncommon thing for thirty freight teams to stop overnight.—*R. W. Cautley, D.L.S., 1907.*

Range 23.

64. *North outline.*—This township is for the most part covered with poplar and willow scrub, with occasional bluffs of poplar from two to four inches in diameter. There is a good deal of brulé, and the occasional stretches of muskeg are full of green spruce and tamarack from two to four inches in diameter. The surface consists of a high rolling plateau about 250 feet above Tawatinaw river, and there are several small creeks flowing across it in a northerly direction. Rated as agricultural land, this township is from first to second class and is suitable for mixed farming. The Athabaska Landing wagon road lies a quarter of a mile east of the northeast corner of section 36.—*R. W. Cautley, D.L.S., 1907.*

68. The country is broken by Athabaska river and spruce swamps, and is unfit for settlement.—*A. W. Ponton, D.L.S., 1906.*

Range 24.

64. *North outline.*—The north boundary of sections 36, 35 and 34 in this township lies principally in muskeg covered with spruce and tamarack from two to eight inches in diameter. The north boundary of sections 33, 32 and 31 traverses a rolling country covered with poplar and willow scrub and old brulé, and is suitable for

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 24—Continued.

farming or grazing, the soil being second class. There are no creeks which cross the line in these sections, but from the presence of small patches of muskeg I believe water would be readily found in summer. There is sufficient timber in the vicinity to supply the needs of settlers both for fuel and farm buildings.—*R. W. Cautley, D.L.S., 1907.*

68. The country is broken by long lakes running north and south, with high ridges between, timbered with fair sized poplar, birch and scattered spruce. This range offers good opportunities to a limited number of settlers, as hay is available in fair quantities and openings in the valleys afford pasture. A trail from Baptiste lake to Moose portage affords access.—*A. W. Ponton, D.L.S., 1906.*

Range 25.

61. This township was reached by following the main trail to Edison to the northeast corner of section 31, township 60, range 25; then following the trail due north to lac des Joncs; thence by the eastern side of the lake. The trail from the east side of the lake runs northwesterly to the northeast corner of section 19. The soil in this township is similar to that found in swamps and muskeg country. It is not suitable for farming. The surface is level, covered with poplar, spruce and tamarack. There is large spruce and tamarack from two to four feet in diameter found in sections 21, 20, 29, 30, 31 and 32. There is no hay. The water in the lakes is fresh. There is plenty of water everywhere in this township. There is one creek which flows westerly entering the township on the north boundary of section 34, and flowing through sections 34, 27, 28, 29, 20 and 19. The climate was dry and warm at the time of survey (August and September), with no frosts. Plenty of dry spruce, tamarack and poplar can be secured for fuel. No coal was found. There are no stone quarries or minerals. The game is moose, deer and ducks.—*J. C. Baker, D.L.S., 1906.*

64. *North outline.*—In this township the land varies a good deal in character; section 36 contains a long irregular-shaped lake surrounded by low broken hills from 40 to 120 feet high and is suitable for grazing rather than agriculture. Sections 35, and 34 contain so much swampy land in the vicinity of the line as to make it third class agricultural land. Sections 33 and 32 are covered with light poplar and willow scrub alternating with bluffs of poplar and spruce from three to six inches in diameter. The land in these sections is of the first class, having an undulating surface and, as far as one can judge from snowshoes, a rich soil is shown by the surface indications, vegetation and general appearance, while section 31 is covered with heavy dry spruce timber and windfalls and would seem to have a lighter soil from the vegetation and presence of second growth jackpine. There are no creeks of such a size as to be noticeable in winter in this township. Numerous tracks of dog sleighs on the lake in section 36 indicate that Indians use it as a route of travel. From a high point on the line in section 36 two lakes are visible to the north-northwest, the bigger of them, estimated to be eight miles distant, probably being Baptiste lake.—*R. W. Cautley, D.L.S., 1907.*

Range 26.

61. There is no trail into this township. In dry weather a wagon may pass through sections 24, 23, 27 and 28 by a trail made by my party. The country, however, is muskeg and difficult to pass through with wagons. The soil along the south boundary and extending approximately one mile into this township is black loam with sandy subsoil. It is suitable for farming but is covered now with thick second

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 26—Continued.

growth poplar. The rest of the township is swamp and muskeg covered with tamarack and spruce too small for timber but suitable for fence rails and firewood. It is not suitable for farm land. There is no hay land. The water is fresh. There is one large creek which flows through sections 24, 23, 26, 27, 28, 29, 32 and 31. The current is slow. There is no water-power. The climate was mild and dry during September and October, with no frosts. Plenty of dry tamarack, poplar and spruce can be obtained for fuel. There are no stone quarries. No minerals were discovered. The game is similar to that found in other parts of Alberta.—*J. C. Baker, D.L.S., 1906.*

64. *North outline.*—This township is principally covered with a thick growth of small poplar and willow, and sections 36, 35, 34 and 33 comprise land well adapted to mixed farming, having a gently undulating surface and good soil, of the first and second classes. In sections 32 and 31 the character of the country gradually changes; small ravines filled with muskeg occur, with patches of heavy timber and brulé and second growth jackpine ridges. The surface becomes more irregular and the soil poorer, so that these two sections range from second to third class in rating. A creek ten feet wide, affording a permanent supply of water, occurs in section 36, and a small creek flows into a marshy pond, to the north of the line, in section 31. There is an abundant supply of timber for the needs of settlers throughout this township.—*R. W. Cautley, D.L.S., 1907.*

Range 27.

58. The north half of this township is reached from Morinville by a cross country trail which leads to Sutherland's mill on or near section 5, township 59, range 26, west of the fourth meridian. Another trail running north from Riviere-qui-barre joins the first near the northeast corner of the township. The south part is reached from Riviere-qui-barre, by going through Independence. This trail strikes about the middle of the south boundary of section 3, which it follows; then after following the south boundary of section 4 for a distance of about a quarter of a mile it turns towards the northwest, leaving the township on the east boundary of section 7. The soil is light in the northern part, improving as we go south. It is a good coat of black and sandy loam over a clay subsoil, altogether suitable for farming. The surface is rolling. Sloping north for about one and one-half miles from the correction line it then drops to the south for the remainder of the distance to the south outline. Except for a part of the east boundary of section 33, which goes through a spruce swamp, the opening of the meridians for the first mile and a half was easy work through small poplar and light brush. From there large areas of poplar from four to twelve inches in diameter are often met with and along the chord north of sections 7 to 12 the brush, especially on the east, was fairly thick and the cutting heavy. The same may be said of the part of the meridians between the two southern chords, especially in the east half. Around the lake on sections 23, 24, 25 and 26 there is a large swamp growing spruce averaging about eight inches in diameter, it reaches to the south boundary of section 23. This timber is good only for fuel. The best timber, consisting of spruce and poplar from six to twelve inches in diameter, is found along the north boundary of section 22. There is on every section sufficient wood to answer all the wants of the settlers for building and fuel purposes for years to come if properly taken care of. There are small hay sloughs on nearly every section, but the most extensive ones are on section 31 and on section 16, where a large quantity of hay has been cut this summer (1906). The water is good wherever found, but the settlers mostly all get their supply from wells they have dug. There are no water-powers nor quarries, nor any minerals that I know of. The only fuel available in the immediate vicinity is wood, but there is plenty of it, especially in the southern part. A few

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 27—Continued.

partridges and some rabbits are the only game that I have seen. There is quite a number of settlers in the township and they all seem to be satisfied with the soil and with their prospects generally.—*Geo. P. Roy, D.L.S., 1906.*

59. *Southern portion.*—The northern part of this township was surveyed last year, and all that has been said about it is applicable to the southern sections or mostly all. This southern part can be reached from Edmonton through Rivière-qui-barre and from there by the trail to Sutherland's mill which is situated on or very near section 5, township 59, range 26, and from there a wagon trail runs west on the correction line. Another trail going through Morinville leads to the same mill. Both trails are in good condition. The soil is generally a fair coat of black loam over a clay or sandy clay subsoil, very well adapted to farming. It becomes lighter farther south. The surface is rolling, mostly covered with small poplar, willow brush and the half burnt remains of old windfalls. There is a chain of swamps and sloughs on part of sections 11, 10, 3, 4 and 5 which reduces considerably the area of farming land in these sections. Most of these sloughs are now dry and partly covered with willow brush, and if cleared would produce a large crop of hay. The settlers have been cutting hay there already. These sections contain also swamps growing spruce and tamarack measuring from two to eight inches in diameter. The space affected by the swamps alternating with hay sloughs is unfit for farming purposes and might be reserved for the preservation of the water supply and the fuel that it contains. Good timber, that is poplar and an equal amount of spruce measuring eight to twenty inches in diameter, is found on the quarter sections cornering on the monument at the northeast angle of section 9. Outside of these timber lands there is, mostly on every section, sufficient poplar and dry spruce for the first wants of the settlers, but unless taken special care of, wood will become scarce in a short time and fuel will have to be procured from the outside. Good water is found in sloughs which are not dry, but the settlers have dug wells which give them all the water they want, some of these wells being forty feet deep. The climate is the same as in Edmonton. There are no water-powers and I have seen no stone quarries or evidence of any minerals. Fuel, as already stated, will be scarce after a few years unless the timber that remains is economically used. Game is not plentiful. A few partridge and rabbits are all the game I have seen. Along the correction line mostly all the sections are occupied and the settlers seem to be satisfied with the soil and with their prospects generally.—*Geo. P. Roy, D.L.S., 1906.*

61. The trail into this township crosses the south boundary near the northeast corner of section 35, township 60, range 27 ; thence crosses sections 2, 11 and 10 to Pembina river. The soil along the river is suitable for farming, but that lying half a mile from the river is muskeg and unsuitable for farming. The country is level, covered mostly with tamarack and spruce swamp. That lying along the river is covered mostly with poplar. The timber is small in this township, except in the northwest and southwest quarters of section 10, where the spruce along the river is large, being from one foot to three feet in diameter. Some hay meadows are found on the west side of Pembina river. They are small. The kind of hay is redtop. The water in the sloughs and lakes is fresh. Pembina river is fresh water. Bath creek which enters the township near the northeast corner of section 35, township 60, range 27, flows northwesterly and empties into the Pembina. The climate is cold and damp in October and November. There are no summer frosts. There is plenty of dry tamarack, spruce and poplar for fuel. No coal was found. No stone quarries or minerals were noticed. The game is similar to that found in other parts of Alberta.—*J. C. Baker, D.L.S., 1906.*

64. *North outline.*—The two and one-half miles contained in this township consist of stretches of muskeg, filled with spruce and tamarack from three to eight inches

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 27—Continued.

in diameter, alternating with irregular sandy ridges covered with jackpine from four to eight inches in diameter. There are no creeks in it, and the land should all be rated as third class agricultural land.—*R. W. Cautley, D.L.S., 1907.*

Range 29.

13. The best route for reaching this township is from Claresholm, a station on the Calgary and Edmonton branch of the Canadian Pacific railway. To reach the southern portion of the township the trail following Trout creek is taken; while the northern part is reached by the trail following Willow creek. Both trails were in good condition, except that they were considerably drifted with snow at the time of my visit (November). The soil is generally of second quality, being a clay or sandy loam, with clay subsoil, and from the excellent crop of grass all over the hills would appear to be very fertile, but owing to the very hilly character of the surface it is best adapted to cattle and sheep grazing. The surface is very hilly prairie, the township being crossed by Trout creek at the south and Willow creek along the north. The north side of the divide in section 18 is covered with willow scrub and a small amount of poplar and cottonwood and a few spruce, the north halves of 17 and 18 being about one-third timbered. Along the west shore of Caron lake the surface is covered with a heavy growth of willow scrub, with a fe wpoplar, pine and spruce, and along the east boundary of sections 2 and 11 were several patches of scrub. The only timber observed was in the southwest corner of section 6. Here there is a small tract of fir, spruce and hemlock, the fir ranging from two to three and one-half feet diameter and the spruce and hemlock four inches to two feet in diameter. This covers one-third of the west half of the southwest quarter of section 6. Hay could be cut almost any place in this township not covered with scrub or timber, and is of the arrow or spear grass variety, but at the present time it is cut chiefly in the valley of Trout creek, where the growth is most luxuriant, but the quality inferior to that on the hills. The water is all fresh, Trout and Willow creeks being spring streams, while several smaller streams fall into these creeks, rising in the interior of the township. The supply is apparently sufficient and permanent. Trout creek is ten to twenty links wide, one to three feet deep, current two and one-half to three miles per hour, and the valley is flooded during spring freshets from one to three feet. As I did not cross Willow creek in this township I can give no information regarding it. There are no water-powers on Trout creek. The climate is said to be warm during the summer months, and generally mild winters with little snow but subject at all times to very high winds. The fuel most easily available in this township is wood—poplar, fir, spruce and cottonwood, and can be procured along the creeks and in the southwest portion of the township. No coal or lignite veins were observed in the township. There are no stone quarries. Outcroppings of sandstone were observed around the lake at the southeast corner of the township, but it was very difficult of access. No minerals of economic value were found in this township. Chickens, foxes, coyotes were quite numerous, with a few deer and wolves, and ducks and geese during the period of open water, and the streams are well supplied with mountain trout, of which there are two varieties.—*A. H. Hawkins, D.L.S., 1906.*

Range 30.

1. A good wagon road known as the Oil City trail leads from Pincher Creek into this township. The soil is gravelly and not adapted for agricultural purposes. The surface is very broken by high bare mountains. The valley of Oil creek, which varies from a quarter to a half mile in width, is more or less timbered with spruce, pine and balsam in all sizes. The water is fresh and the supply plentiful. A water-power could

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 30—Continued.

be developed from Oil creek. The fuel is wood and can be procured from any section. No hay exists in this township. Good limestone can be had from almost any section. The game is deer and brown bear. Mountain trout are also plentiful. The only mineral found was crude oil. The Rocky Mountain Developing company have completed drilling a well on the northeast quarter of section 30, from which they can pump a small quantity of oil. They have another well nearly completed on the same quarter and an outfit ready to start in a second well on the same quarter. The Oil City townsite is laid out partly on section 25, township 1, range 1, west of the 5th meridian, and partly on section 30, township 1, range 30, west of the 4th meridian. Spruce, balsam and pine timber, in small sizes, is plentiful throughout the township. Trees up to thirty inches in diameter were found on the southwestern part of section 25, and on section 11. There is, however, no large quantity of this heavy timber. The climate is very changeable and no doubt summer frosts do occur.—*Lennox T. Bray, D.L.S., 1906.*

3. *Sections* 13, 24, 25 *and* 36.—These sections lie only a couple of miles west of Twin Butte, and can be easily reached from it by good trails which lead into and near these sections. The soil is of a good quality, being a deep rich loam with a clay subsoil. It would be suitable for grain growing, but owing to the high altitude of the locality it is very difficult for the grain to ripen. The surface of these sections is rolling and mostly covered with thick scrub willow and poplar. Poplars are found up to six inches in diameter. There are a few sloughs and open ridges throughout these sections. The water in some of the sloughs is fresh, while in others it is brackish. Several good spring creeks flow easterly across sections 13 and 24. The climate of this locality is apt to be very changeable, owing to it being so near the mountains. Summer frosts occur. The fuel used is wood, and can be procured from some of the canyons leading into the mountains about three or four miles west of these sections. No water-powers were found in these sections. No stone quarries, no hay and no traces of minerals were found. Deer and prairie chickens are the only game. Section 13 is rolling, in its central part more or less open, on its boundaries it is covered with thick willow and young poplar. Section 24 is partly open prairie and gently rolling. Sections 25 and 36 are rolling land covered with thick willow and poplar up to six inches in diameter. There are a number of sloughs on these sections, and the northwest quarter of 36 is broken by Margaret lake.—*Lennox T. Bray, D.L.S., 1906.*

4. This township can be reached from Pincher Creek by good trails which lead into it. The soil is of a good quality, being a deep rich loam with a clay subsoil, and would be suitable for grain growing were it not for the high altitude of the locality. Some of the settlers grow very good oats and intend trying other grains. The surface is rolling and scrubby, though there is nearly as much clear land as there is scrub. There is no timber in this township except young poplar which on parts of sections 8 and 17 attain a size up to six inches in diameter. Some black poplar along Drywood river through section 8 were found up to twenty inches in diameter. Young poplar occurs in almost every section. Good hay is harvested from any of the openings in the township. A good hay meadow occurs on the south half of section 9. The water in all the streams is fresh and the supply seems to be permanent. Some of the sloughs in the southeastern part of the township are inclined to be alkaline. The fuel used is mostly wood and can be procured just west of this township in the ravines leading into the mountains. No water-powers occur in this township. No stone quarries and no indications of minerals were found. The game is prairie chickens, and a few deer were seen. The climate of the locality is very good. Although no summer frosts occur, still frost does occur quite early in the fall. This locality up

TOWNSHIPS WEST OF THE FOURTH MERIDIAN.

Range 30—Continued.

until the present has been used for grazing purposes. Sections 1, 2 and the east half of 3 are rolling land covered with willow scrub and young poplar. There are open areas all through these sections. Sections 1 and 2 are broken by Yarrow creek, which has high banks. The southeast quarter of 2 and the southwest quarter of 1 are broken by a lake. Section 4 and the west half of section 3 are high rolling land and mostly open. Section 5 is rolling and covered to a good extent with scrub. Sections 8 and 9 are broken by Southfork creek. Section 8 and the north half of 9 are high rolling land mostly covered with scrub and young poplar up to six inches in diameter. The south half of section 9 is mostly open and level and makes a very good hay meadow. Sections 10, 11 and 12 are rolling land and partly covered with willow scrub. Some of section 12 has been cultivated. Sections 15, 16 and 17 are broken by Northfork creek and are partly covered with scrub. Sections 21 and 22 are gently rolling land and mostly covered with willow scrub and young poplar. Section 20 is mostly open and gently rolling.—*Lennox T. Bray, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 1.

1. A good wagon road known as the Oil City trail leads from Pincher Creek into this township. The soil is gravelly and not adapted for agricultural purposes. The surface is very broken by high bare mountains. The valley of Oil creek, which varies from a quarter to a half mile in width, is more or less timbered with spruce, pine, and balsam in all sizes. The water is fresh and the supply plentiful. A water-power could be developed from Oil creek. The fuel is wood and can be procured from any section. No hay exists in this township. Good limestone can be had from almost any section. The game is deer and brown bear. Mountain trout are also plentiful. The only mineral found was crude oil. It can be seen oozing out of the banks of Seapage creek on section 25. Several prospecting outfits are working in these townships drilling for oil. The Rocky Mountain Developing Co. have part of a drilling outfit on the southeast quarter of section 25, and part of an outfit on the northeast quarter of section 14. The Pincher Creek Oil Co. are drilling a well on the northeast quarter of section 25. The Oil City townsite is laid out partly on section 25, township 1, range 1, west of the fifth meridian, and partly on section 30, township 1, range 30, west of the fourth meridian. Spruce, balsam and pine timber, in small sizes, is plentiful throughout this township. Trees up to thirty inches in diameter were found in the southwestern part of section 25 and on section 11. There is, however, no large quantity of this heavy timber. The climate is very changeable and no doubt summer frosts do occur.—*Lennox T. Bray, D.L.S., 1906.*

2. This township can be reached by a pack trail which branches from the Oil City trail just as it crosses Blakiston brook in township 2, range 30, west of the fourth meridian. By doing a little road building and driving up the bed of Blakiston brook we were able to use a wagon as far as section 9, but beyond this section it would be difficult to get a wagon. The soil of this township is gravelly and not at all adapted for any agricultural purpose. The surface is very broken by high bare mountains. There are a few small flats which are more or less covered with scrub. Jackpine, spruce and balsam grow on the mountain sides up to a certain height. The water is fresh and the supply appears to be sufficient. The fuel used is wood and can be procured from any section. There is plenty of good limestone in every part of the township. No hay of any account grows in this township, and no indications of minerals were found. The climate is very changeable, summer frosts undoubtedly do occur. The game is brown bear, deer, sheep and goats. Water-power can be developed on both

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 1—Continued.

forks of Blakiston brook by damming. On section 14 the south fork has a fall of about twenty-five feet. The timber is pine, spruce and balsam. Most of the flats and mountain sides are covered with trees from two to eight inches in diameter. On the northern parts of sections 21 and 22 our lines ran through a block of timber measuring from six to forty inches in diameter. Another block of large timber was seen to be located on about the south half of section 8. In surveying this township I was compelled to run a good many quarter section lines in order to follow the courses of Blakiston brook. The valley adjoining this brook varies in width from about a quarter to a half mile, though in places it may be narrower. My lines on both forks of Blakiston brook could have been continued about two miles farther west without any great difficulty, but on account of being called to another district I was compelled to stop where I did.—*Lennox T. Bray. D.L.S., 1906.*

15. It is about twenty miles by a fairly good but hilly road from this township to Nanton, a small but flourishing town on the Macleod extension of the Calgary and Edmonton branch of the Canadian Pacific railway. Another trail from Stavely, also a town farther south on the same line of railway, joins the former trail a few miles east of this township. The soil is composed principally of a black loam, varying in depth from three to eighteen inches with generally a clay subsoil. On the hills and ridges the soil is stony and gravelly. It is suitable for the growth of any crops peculiar to this latitude, providing the climatic conditions are favourable. The surface is very hilly and is partly prairie, but mostly bush and brush. The timber still standing is somewhat scrubby. There has been some very good timber, such as banksian pine, spruce and poplar. The best of it, however, has already been cut. There was a portable sawmill just south of the south boundary of section 1, which has since been removed to another locality. The settlers forty and fifty miles to the east have also for some years past been cutting the best of the timber for their necessary farm buildings. There are no regular hay meadows, but the herbage along the sidehills and valleys attains a luxuriant growth and makes excellent hay. It is a mere matter of humidity, as when there is plenty of rain there are good hay crops, without any irrigation. If, however, it happens to be a particularly dry season, irrigation ditches are made use of. The water found here is of a superior quality, as many springs take their rise in the hills. At the time of my survey they were running strong, and showed no signs of being easily exhausted. There are no water-powers in the township. The climate, owing to the altitude, and the close proximity of the mountains, is not favourable for the ripening of cereals, and only the hardiest kind of roots or vegetables do well. So far there is plenty of fire-killed timber for fuel, but coal may be obtained at no great distance in the foothills. There are no stone quarries, but stone may be procured on the ridges, in the future, if required. No minerals, of any economic value, were found. Game also is scarce, only a few grouse or partridges having been observed. Taking into consideration the vigorous growth of the grasses and the fact that the climate is unfavourable for the ripening of cereals, it is plain that this township is more adapted for cattle-raising. The herbage for pasturage is in abundance and although the winters at times may be severe, with sufficient care and a good supply of provender for exceptionally bad seasons, no heavy losses may be anticipated. As a rule, horses do not require to be fed during the winter months, provided they have the run of new pasture, even if the snow is deep, as they can rustle or paw, but cattle, if a crust forms on the snow, require to be fed. Fortunately, even after a heavy fall of snow, a chinook may spring up and thaw the snow, and thus enable the cattle to rustle their own sustenance, without any particular effort on the part of the cattlemen. When hay is not very abundant a snow plough may be used, to clear the prairie for the benefit of the calves. A number of settlers have come in within the year, and nearly all are provided with the means of sustenance, having brought a number of

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 1—Continued.

cattle along. Those that have no cattle are getting a start by working out for wages. They are a very desirable class of settlers.—*C. F. Miles, D.L.S., 1906.*

Range 2.

5. This township is reached from Pincher Creek by a good wagon road which passes through it leading to the oil wells on the south fork of Oldman river. The soil is more or less gravelly, and is best suited for grazing, though a number of settlers are trying to farm it in small patches. The surface is very rough and broken, though there are some small flats which are not. It is covered mostly with scrub poplar, jackpine and spruce which will be mentioned below. Good hay is cut on parts of sections 8, 21 and 29, and the open slopes of some of the hills. This town ship is exceptionally well watered by numerous spring creeks, which afford the best of fresh water. Mill creek runs northerly through the eastern tier of sections. Gladstone creek runs northeasterly across the southern and central part of the township. Beaver creek runs northeast across the northwestern part of the township. Mill creek has been used for driving timber, and with a few dams Gladstone creek could also be used. The climate is very changeable and summer frosts occur. Plenty of limestone could be quarried out of the banks of Mill creek, and in various parts of the northwest part of the township. The fuel at present is wood, which can be procured from almost any section. Coal shows itself in the north bank of Gladstone creek near where it empties into Mill creek. No other minerals were seen. The game is blacktail deer and brown bear. Sections 13, 24 and 25 are broken by Mill creek, and are mostly timbered west of the creek. Section 35 is rolling land covered with a thick growth of poplar. Section 26 is rough and broken in its west half; the east half is open, nearly level land. Section 23 is open through its central part, but rough and covered with timber in its northwest and southern parts. Section 14 is sloping, rolling land covered with spruce, pine and poplar. Section 15 is more or less open. Sections 16, 17 and 18 are high rolling land, covered mostly with spruce up to ten inches. The south slopes of the hills are open in patches. These sections slope to the north. Sections 19, 20, 21 and 22 are rough and high rolling land covered mostly with spruce and poplar. Spruce measuring up to fifteen inches in diameter covers the central eastern part of section 21. Section 27 is very rough and broken by hills. Good timber up to twelve inches in diameter is to be found on it. Section 28 is partly open in the southeast quarter; the southwest quarter is very rolling, and covered with pine and spruce up to six inches in diameter. The north half is very rough and broken. Spruce up to twelve inches in diameter is found on it. The east half of section 29 is rough, rolling land, lightly timbered; the west half is partly open. Section 30 is high, rolling land covered with spruce, pine and poplar up to eight inches in diameter. Section 31 and the north half of section 32 are very rough, and broken by high bare hills. Good timber grows in the ravines. The south half of section 32 is sloping, rolling land, covered with a good growth of spruce and pine up to eight inches in diameter. A part of the southeast quarter is open level land. Section 33 and the west half of section 34 are very rough, and broken by high hills and ravines. The east half of section 34 is rolling land covered with a thick growth of poplar. All through this township the south slopes of the hills were less wooded than the north slopes, and in most cases the imber was young poplar.—*Lennox T. Bray, D.L.S., 1906.*

13. This township may be reached by a fair trail from Nanton or Stavely, on the Calgary and Edmonton railway, about thirty-five miles distant. The soil in the bottom lands consists of a rich black loam, which, if climatic conditions permit, could produce any crops. A high ridge traverses the centre of the township; there are two gaps, through which Langford and Westrup creeks flow into the south branch of

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 2—Continued.

Willow creek. Another high rocky ridge cuts through the easterly tier of sections. Similarly, other rocky ridges cut through the westerly half of this township. The valley between these ridges furnishes excellent pasture, and in the open parts many hundreds of tons of hay are cut by the ranchers for their cattle. The ridges are more or less covered with timber, some of which is of considerable size, such as spruce and jackpine; some good fir is also to be met with. Much of it has already been cut by settlers and ranchers from a distance, but there is still a bountiful supply for future needs. A luxuriant growth of grass is found on nearly all the uplands. The supply of water in the creeks appears to be unlimited, and is of good quality, apparently but little impregnated with alkali. There are no available water-powers. With regard to the climate the reports are contradictory. Each one interviewed makes his statements to suit his own interests. Ranchers affirm that no crops, either cereal or roots can be grown here, whereas settlers maintain the contrary. Of fuel, there is a plentiful supply in the hills for years to come, consisting of poplar, spruce and jackpine. Coal too, may be procured at no great distance. There are no quarries being operated. Minerals of economic value were not observed. With regard to game, it is being rapidly exterminated by the Stony Indians, who are in the habit of hunting to the west of this township in the early winter. Some of them, a part of a large band, called at my camp to dispose of some of the deer they had killed in this vicinity. The valleys of this township are pretty well settled, but owing to some differences between the ranchers and settlers, it is possible that the latter may have to abandon their homesteads and improvements and look for land in some other locality. All in all, I consider this township essentially a cattle country.—*C. F. Miles, D.L.S., 1906.*

14. Fairly good, but very hilly trails reach this township from Nanton and Stavely—about twenty-five miles distant—two small but flourishing towns on the Macleod extension of the Calgary and Edmonton branch of the Canadian Pacific railway. The nearest post office is Willows, on section 12, in township 14, range 1, on Willow creek, where there is a weekly mail from Nanton. The soil, generally, is a rich black loam varying from three to eighteen inches in depth, with clay subsoil. On the hills and ridges it is mostly gravelly and stony. It is suitable for raising any crops indigenous to the altitude, provided climatic conditions are favourable. The surface is mainly hilly, high ridges traversing the township from south to north with intervening valleys. A fine valley occupies parts of sections 2 and 3, 10 and 11, 15 and 14 and sections 22 and 23. There is also the valley of Willow creek, which lies in parts of sections 25, 26, 27 and 28. Another valley runs from south to north through the easterly halves of sections 4, 9, 16 and 24, but it is more or less swampy and brushy. Timber is chiefly found along the side hills, but not in sufficient quantities to be of a marketable value. It consists of poplar, banksian pine and spruce. On the tops of the ridges generally some Douglas fir is to be found, and although sometimes quite large, it appears gnarled and stunted. A considerable quantity of hay is cut in the valley, wherever it is clear of willow scrub and sage brush. There are no water-powers, stone quarries or minerals of economic value. The climatic conditions are not favourable for the ripening of cereals, and no attempt seems to have been made in this direction owing to the prevailing summer frosts. The hardiest kinds of vegetables and roots might ripen, but it is doubtful if potatoes would. For fuel there is an abundance of fire-killed timber along the side hills, and in some of the ravines. Game is not plentiful. Some grouse and partridges were observed, and there were signs of deer. The creeks, however, are well stocked with different varieties of trout and grayling. The water from the springs rising in the hills or ridges is pure and palatable, as is also the water in Willow and Rice creeks, which are fed from the springs. An old deserted cow camp in section 28 has again been taken possession of by some cattlemen. They have both cattle and horses, and they cut

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 2—Continued.

a large quantity of hay last summer on sections 27 and 28, mostly on the uplands. A rancher on section 10 has not been in possession many years. He cuts his hay on the easterly halves of sections 3 and 10. The settler on the southwest quarter of section 14 has but a small number of horses. He is quite a new arrival, and cuts his hay on his own claim. These are the only settlers in this township. The beef raised here, as is the case in the other townships of my survey, is of a superior quality. I have frequently seen cattle as fat as if they were stall-fed. There are numbers of herds of Galloways which appear to thrive exceptionally well on the herbage prevailing here. —*C. F. Miles, D.L.S., 1906.*

15. *Southern part.*—There are fairly good wagon roads from Nanton to this township, Nanton being a small but growing town on the Macleod extension of the Calgary and Edmonton branch of the Canadian Pacific railway. It is only about twenty-five miles by the trail which is good for loads almost the year round. Going by the north trail is somewhat longer, but the heaviest hills on the south trail are avoided. The soil is a black loam with generally a clay subsoil. It might produce anything peculiar to this latitude, were the climate favourable. The surface is hilly, partly timbered and scrubby, with willow growing densely in many places, and of such dimensions as to make them suitable for fence posts. Where, however, there are openings, there is generally a luxuriant growth of grasses. The timber, except for fencing and other similar purposes, has no marketable value. There are no hay meadows in the area surveyed by me during the past season, with the exception of a small area along the south boundary of section 3, the hay required by the cattlemen being cut mostly on the uplands. There is good water from the springs which take their rise in the hills. Many of these springs empty into the ponds on sections 3, 9 and 16. These ponds cover quite a large area. They are shallow, with muddy bottoms, and are not easily approached by cattle. They are full of weeds floating on the top of the water, and are surrounded by swamps. The water from the springs is pure and palatable, but in the ponds it is impregnated with decayed vegetable matter. There are no water-powers. The climate is not favourable for the ripening of cereals, and only the hardiest of vegetables or roots arrive at a state of maturity. Oats may be grown for green feed, but will not ripen generally. Potatoes were cut down by frost on the morning of August 4 in three different localities. There is sufficient fire-killed timber for fuel for immediate requirements, and coal may be obtained at no great distance in the foothills. There are no stone quarries, nor were minerals found of any commercial value. Game is becoming scarce; grouse and partridges were seen occasionally, and signs of deer were observed. In conclusion I may say that the climatic conditions are not favourable for general farming purposes, but owing to the abundance of nutritious herbage it is an ideal cattle country. Horses may run at large all the year round and thrive, but cattle require to be fed in severe weather, when a crust has formed on the snow. In such cases it is necessary to have hay provided, more particularly for the younger animals. In ordinary seasons any quantity of hay may be obtained, but in dry seasons irrigation has to be resorted to.—*C. F. Miles, D.L.S., 1906.*

Range 3.

5. The best route for reaching this township is by a wagon trail from Pincher Creek, which runs generally in a southwesterly direction from that town. It can be travelled only in the summer and winter months, the mud being too deep after the road thaws in the spring. During the months of June and July Beaver creek is very high, due to the melting of the snow in the mountains, and in consequence of it being necessary to ford this stream many times, some difficulty might be experienced

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

in going over the road at that season. Occasionally the high water will make the road impassable. The soil in this township consists of black loam or sand with a clay subsoil. A few vegetables can be grown, but the land suitable for agriculture is very limited on account of the mountainous nature of the country. It is suitable for lumbering and mining. The best tracts of timber consist of spruce and pine from twelve inches to thirty-six inches in diameter, but have already been purchased by lumbermen. There is also evidence of the presence of petroleum, but whether it will be found here in paying quantities remains to be determined. There are a few sloughs which produce a coarse hay, but they cannot be said to produce it in any quantity. The country also affords as fine a horse range as can be found in western Canada, there being a good growth of bunch grass on the hills, and a never-failing supply of excellent water. The south fork of Southfork river runs through the centre of the township. It is a large stream and flows at the rate of about five or six miles an hour, with a large volume of water. The low lands adjoining this stream may be flooded at times during extremely high water. The rain and snowfall in this valley is very great. The precipitation might easily amount to one hundred inches during the year. Five hundred horse-power could easily be developed by the construction of a dam in this stream. I spent only parts of the months of October, November and December in this locality and therefore cannot at present, speak positively with regard to summer frosts, but I was told by settlers that they have experienced light frosts during the summer. Stone might be quarried in some places, but the soil is too deep to admit of any being exposed to view. There are quantities of speckled trout in Southfork river averaging about two pounds. There are some fur-bearing animals such as beaver, mink, rabbits, lynx, also a few red deer.—*W. F. O'Hara, D.L.S., 1906.*

6 *and* 7,, *Parts.*—These parts can be reached by a trail which branches to the south from Crowsnest trail on section 16, township 7. It has been used as a wagon road at some time, but the bridges on it now are unsafe. Pack horses afford about the only means of reaching these sections. The soil of these sections is a sandy loam and would be suitable for grazing. The surface is very broken and mountainous as will be described below. The only hay is the grass on the open side hills. The water is fresh and the supply apparently sufficient. The climate is very changeable, and there are summer frosts. The fuel is coal and wood. Coal has been mined on section 31 and wood can be procured from any section. Plenty of limestone can be quarried on any of the sections. No game was seen. No water-powers occur on these sections, and no traces of minerals outside of the coal mentioned above. Section 19 is rough and broken by mountains. A valley containing jackpine runs southeasterly out of it. Sections 30, 31 and 32 are broken by mountains; a valley runs northerly through sections 30 and 31, the higher end of which is mostly open, but on the north half of 31 it is timbered with young jackpine and spruce. A coal mine has been worked on the north half of 31, and several empty buildings stand in the vicinity. The side hills of these sections are mostly bare rock. Section 32 lies mostly up on the hills; it is very rough and is covered to a great extent with jackpine and spruce up to ten inches in diameter. The central southern part of section 6 is mostly a valley timbered with spruce and jackpine, the rest of the section is very rough and broken. Sections 7 and 8 are very rough and broken; they are mostly covered with spruce and jackpine up to ten inches in diameter. Section 5 is rough and broken in its west half and generally covered with spruce, pine and poplar. Byron creek flows through the northwest quarter section 31 and easterly through the south halves of sections 5 and 6. An old wagon road leading as far as the coal camp passes through the south halves of sections 5 and 6. There has been a railway right-of-way brushed out on parts of sections 6 and 31.—*Lennox T. Bray, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

8. There is a pack trail leading from Frank, which crosses the mountain running northeasterly through the township. The soil is more or less gravelly though in places a deep rich loam is found. The surface is rough and scrubby in the parts surveyed, as will be explained below. Pine and spruce timber can be got from the ravine leading into the mountains. Hay has been harvested on parts of sections 23, 24, 25, 26, 35 and 36. The water is fresh and there is a good supply. The fuel used is wood and can be procured from some of the ravines leading into the mountains. Stone is plentiful along the mountains. No minerals were found. Those parts of the township lying west of the Livingstone range of mountains can be reached by a wagon road which runs from Frank to Lille. These parts are very rough and have been timbered, but the timber has mostly been burned. No game was seen. The parts east of the Livingstone range of mountains are well adapted for ranching purposes. The climate is changeable and summer frosts occur. Sections 25 and 36 are open and lie mostly up on high bare hills. Parts of the north half of 36 have been improved. Breaking has also been done on the northern part of 25. Sections 23, 24, 26 and 35 are rolling and mostly open but scrubby in patches. Several small lakes occur on the east half of section 35. Sections 2 and 3 are rough and lie mostly up on bare hills. Section 2 is scrubby in its northeast quarter and section 3 is scrubby in its central southern part. Section 11 is rough and broken in its northwest quarter, the remaining quarters are rolling and partly covered with scrub. The southwest quarter of section 14 is very rough, while the southeast quarter is rolling, scrubby land. The southeast quarter of section 10 is rolling and partly covered with scrub. A part of this quarter is cultivated. The remainder of section 10 and the south half and northwest quarter of 15 are mostly open and lie high up on the side hills. The east halves of sections 4, 9 and 16 are very rough and broken and reach to about the summit of the Livingstone range. The east halves of sections 6 and 7 are very rough and broken and covered with standing burnt young spruce. The west halves lie well up on the side of Goat mountain and are very rough. The west half of section 18 is very rough and lies upon the side of Goat mountain. It is covered with burnt young spruce. The east half is rolling and has been mostly cleared. Section 5 is very rough and broken by hills and covered with burnt young timber. The west halves of sections 8 and 17 are very rough and covered with burnt timber in the south, while fine large green spruce and pine cover the northern part of the northwest quarter of section 17 and the southwest quarter of section 20. The east halves of sections 8 and 17 are mostly bare rock and lie well up on the mountains. Soft coal is found in abundance west of the Livingstone mountains. The Frank and Lille railway runs up the Gold Creek valley which is mostly timbered.—*Lennox T. Bray, D.L.S., 1906.*

9. There is a pack trail leading from Frank, which crosses the mountain on section 4, and thence northeasterly through the township. The soil is more or less gravelly though in places a deep rich loam is found. The surface is rough in the parts surveyed and scrubby, as will be explained below. Pine and spruce timber can be got from the ravines leading into the mountains. Hay has been harvested on parts of sections 1 and 2. The water is fresh and there is a good supply. The fuel used is wood and can be procured from some of the ravines leading into the mountains. No minerals were found but prospectors report having found good magnetic iron ore on section 21. Those parts of the township lying west of the Livingstone range of mountains can be reached by a wagon road which runs from Frank to Lille. These parts are very rough and have been timbered but the timber has mostly been burned. No game was seen. The parts east of the Livingstone range of mountains are well adapted for ranching purposes. The climate is changeable and summer frosts occur. Most of the east halves of sections 1 and 12 and the southwest quarter of 1 lie in a valley which is partly covered with scrub. The soil here is good. The south half and

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

central northern part of section 2 and the central part of section 11 are in a rolling valley. Open areas occur in this valley but the surface is mostly covered with willow and poplar scrub. The remaining parts of these sections are very broken by high bare hills.—*Lennox T. Bray, D.L.S. 1906.*

11. The best route for reaching this township is to leave Cowley station, on the Crowsnest branch of the Canadian Pacific railway, travelling north to Oldman river, and along Oldman river through the Gap, to Livingstone river. The soil is a black loam covering sand in the flat valley of Livingstone river. It would be suitable for the growth of cereals except for the heavy frosts in summer. The valley of Livingstone river in this township is a narrow prairie, timbered in the northern portion of the township with pine, small poplar and willow scrub. The pine and spruce is from six to ten inches. In the flat valley there is a good quality of hay. The water is fresh and very clear; the supply is sufficient and permanent. Livingstone river varies from fifty links to two chains and fifty links in width, and from three links to fifteen links in depth. It has a probable average width of seventy-five links and a depth of four links, with a flow of nearly four miles an hour. It seems improbable that the land could be flooded. Livingstone river is available for the development of horse-power. It is nearly a continuous rapid in this township. Power could be developed by the construction of dams. The climate is very dry. The inhabitants say there is frost every week, with the exception possibly of one or two weeks in August. Fallen timber on the mountain and hill sides would supply fuel. On the east boundary of section 7 there is a seam of bituminous coal forty links in width at least. No stone quarries or minerals of economic value were observed. The game consists of a few partridge and prairie chicken, antelope, mountain sheep and bear. Livingstone river is fairly teeming with salmon trout.—*A. L. McLennan, D.L.S., 1906.*

12. The best way to reach this township is to leave Cowley station on the Crowsnest branch of the Canadian Pacific railway, travelling north to Oldman river, and along Oldman river through the Gap, to Livingstone river. It is nearly all sand, suitable for the growth of pine. The surface is mountainous, timbered with spruce, fir and small poplar. On the western portion of the township there is spruce and pine up to ten inches. There is no hay. The water is fresh, and the supply seems to be permanent. Small rapid streams flow into Livingstone river, varying in width from ten to twenty links, and two links in depth, with a strong current. The land could not be flooded. The water-power in these creeks could not be developed. The climate is very dry. The inhabitants say there is frost every week, with the exception possibly of one or two weeks in August. Dry fallen timber on the mountain sides is readily available for fuel. I saw no coal or lignite in this township. The summit of the mountain is composed of sandstone and conglomerate. Hematite in the form of kidney-shaped specimens were found in the bank of Livingstone river. A few partridge and prairie chicken, antelope, mountain sheep and bear were the game seen.—*A. L. MacLennan, D.L.S., 1906.*

17. A good trail from High River reaches this township. High River is a flourishing town on the Calgary and Macleod extension of the Canadian Pacific railway, about thirty miles distant. As my work consisted of subdivision of only parts of the southerly two tiers of sections, my remarks will apply mainly to that part of the township. Generally speaking, the soil consists of a rich black loam, varying in depth from six to eighteen inches along the flats and side hills. On the higher elevations it decreases in depth, and on the summits of the hills rock is frequently exposed. The soil is fit to raise any crops, if climatic conditions are favourable. It is a hilly

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

township, though there are some fine flats along Pekisko creek, which is bordered by a fringe of timber. The remaining parts are alternately open prairie and willow brush, the former predominating. The timber bordering Pekisko creek is poplar and balm of Gilead up to about eighteen inches in diameter. There are no hay meadows of any account, the hay being principally from the uplands, where the grass grows luxuriantly. This township is well watered by creeks and springs, the principal stream, Pekisko creek, traverses sections 3, 2, 1 and 12, averaging about a foot in depth and about one chain in width. It does not appear liable to flood to any extent. No water-powers are available, or could be developed without great expense. The climate is not favourable for ripening of crops, and the settlers seldom attempt to grow anything, except for green feed, owing to summer frosts prevailing. Fuel might be obtained in the townships to the west, where timber appears plentiful, but coal is found and mined in several places along the banks of Highwood river, in the adjoining townships to the northeast. There are no stone quarries in operation, but the country rock is found frequently exposed in the hills, and might be utilized for building purposes. No minerals of economic value were observed. The only kind of game noticed was prairie chicken, but fish (different varieties of trout) appear plentiful in Pekisko creek. This part of the district is essentially a grazing country, and cattle as well as horses appear to thrive on their pasturage. Most of this land appears to be under lease, so no new settlers may be expected to come in. The pasturage can therefore be more conveniently regulated according to the requirements of those interested.—*C. F. Miles, D.L.S., 1906.*

18. This township is comparatively easy of access by trail from High River, a station and town on the Calgary and Macleod extension of the Canadian Pacific railway. Trails also from the north, from Lineham and Millarville, and from the south from Pekisko offer easy access into this township. The trail from High River has recently been diverted into road allowances and on that account, during very wet weather is somewhat impassable, as it proved to be at the time of my survey (May). The valley of Highwood river extends from one-half to three-quarters of a mile north of the river. There are no bottom lands adjacent to the river, the lowest being about seventy-five feet above the water level. The higher flats form excellent hay lands, those nearer to the river, of a somewhat lower level, afford good grazing; the soil, however, is gravelly and stony. The north boundary runs along a range of high hills. South of the river the soil consists of black loam varying in depth from six to eighteen inches, with generally a clay subsoil. South of the river the land rises gradually for a couple of miles, covered in many places with a more or less dense growth of willow. From here to the south boundary it is more open and hilly, with a gradual descent to the south boundary, affording excellent pasture for both cattle and horses. Along the south side of Highwood river there are some small groves of spruce and also of poplar, the former attaining a diameter of about twelve inches. There is no more timber than is required for the needs of the incoming settlers. There are a few hay meadows, but most of the hay is obtained from the uplands. Highwood river is not easy of access for cattle owing to its precipitous banks. There are numerous springs however, and small creeks, taking their rise in the hills, both from the north and south, containing good water. There are no water-powers available. The climate is not favourable for raising crops to any extent, although potatoes and vegetables have been grown successfully in some of the eastern sections. Frosts, however, prevail during most of the summer months. There is sufficient dead timber, fire-killed, as well as small poplar for fuel, but there is also an unlimited supply of coal now being mined, immediately to the east of this township. No stone quarries were located, although rocks are exposed in various places in the river cutbanks. No minerals of economic value were observed. For game, there are grouse, chickens and rabbits, and

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

the river is well stocked with trout of different varieties. Taking everything into consideration, this township may be considered as excellent for stock-raising, but not for general farming.—*C. F. Miles, D.L.S., 1906.*

19. Fair trails from either High River or Okotoks reach this township. Both these places are stations on the Calgary and Macleod extension of the Canadian Pacific railway, and are within twenty miles of this township. A surveyed trail traverses sections 12, 13, 14 and 23, which, however, is almost impassable. Consequently settlers have adopted a trail following the ridge through sections 12, 13, 24 and 26; this, however, may be closed at any time by incoming settlers fencing their claims. The soil consists of a rich black loam and is well adapted for growing any kind of crops, provided the climatic conditions are favourable. The surface is hilly and rolling, partly prairie, the easterly two tiers or two and one-half tiers of sections being more particularly scrubby. South of Tongueflag creek the township is covered in part with a dense growth of large willow. The remaining westerly part is more wooded; both spruce and poplar are found, reaching up to eighteen inches in diameter. The timber, however, is not in sufficient quantities or of large enough areas to be set apart as timber berths, but should be reserved for the need of settlers. Most of the hay used here is cut on the uplands. Some of the lands along the surveyed trail would produce good hay. The trail is located along a valley, but is almost impassable on account of its swampy nature, and because of the springs that rise in the hills to the east and overflow this valley in places. This township is well supplied with water both by springs and creeks, Sheep river traversing the northwest quarter and Tongueflag creek traversing the southerly second tier of sections. The water is somewhat alkaline. The climate is not very favourable for the ripening of crops; some vegetables thrive and oats are found to ripen in some seasons, but on the whole, this township may be pronounced as being better adapted for stock-raising than for the growing of cereals. A good many cattle are being pastured here already, and with other settlers coming in, the number will be increased. Fences will be erected, which will limit the area for pasture very considerably. It is possible, that with the cultivation of the soil summer frosts may be eliminated, as has been the experience of settlers in the other provinces. So far there is a plentiful supply of fuel within the limits of this township. If this should be exhausted through destructive fires, there is an unlimited supply of coal to the north of this township, and also, according to report, on Sheep river to the west. There are no stone quarries in operation, but rock is exposed in various places along the cutbanks of Sheep river. No minerals of any economic value were observed. With regard to game, mountain grouse and prairie chickens, also rabbits and a few ducks were observed. Deer tracks also were seen occasionally.—*C. F. Miles, D.L.S., 1906.*

20. This township may be reached by a fairly good wagon road from Okotoks, a flourishing town on the Calgary and Macleod extension of the Canadian Pacific railway, about fifteen miles distant. A good wagon road also leads to Calgary by way of Millarville and Priddis, about thirty miles distant. The soil consists of a black loam varying from six to eighteen inches in depth, (the deeper predominating) with clay subsoil. It is suitable for the cultivation of any crops peculiar to the latitude provided the climatic conditions are favourable. In parts, potatoes and other hardy vegetables, as well as oats and barley have been grown successfully. The surface is hilly and rolling, frequently timbered with small groves of poplar and spruce on the northerly exposure of the hills, where it is also generally springy; scrub willow prevails to a greater or less extent on the low lying lands. The timber in a few instances reaches up to twelve inches in diameter. There is, however, no more than is

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

required for the needs of the settler. There are no hay meadows of any extent, much of the hay being made on the uplands. Water appeared plentiful at the time of my survey (June), it having been a very wet spring. The creeks were running and some fine springs were noticed on the hillsides, the water being of a very good quality. There are no water-powers within the limits of my survey. During my stay of about two weeks in this township, there were no frosts, and I concluded that climatic conditions might be more favourable for the raising of crops in the eastern than in the western half. Areas for pasture are becoming very limited, and it will be but a very short time before this township is overstocked. For fuel there is at present quite an amount of standing timber, partly fire-killed, but a good quality of coal is found and mined within a convenient distance in the adjoining townships to the east. There are no stone quarries in operation, nor were there any minerals of economic value observed. A coal seam has been worked in Sheep river in the southerly part of this township, but since abandoned. As for game only a few chickens and partridges were observed. I find that men with families, who came in here with very small means, have arrived at a state of comparative affluence by hard work and economy in a very few years. Their horses and cattle are not roaming at large; they have quite a few head of milch cows, and sell a considerable amount of butter every week, also poultry and eggs, and raise sufficient vegetables for their own use as well as for market in the nearest town or village. They are now living in the enjoyment of the fruits of their labour and enjoy greater comforts than even they knew before they settled here. The female members of the families are even more enthusiastic about their life and interests than the male members. Yet none had to work so hard or suffer the same privations as the old settlers in the one-time backwoods of Ontario.—*C. F. Miles, D.L.S., 1906.*

50. The easiest and by far the best route to reach this township is by the trail leading from Leduc, passing Calmar and Telfordville, and thence westerly across range 2 to the homestead of C. M. David on the southwest quarter of section 12. The trail is good throughout and has been graded from its starting point to Telfordville. Another route from Edmonton by way of Sprucegrove, Stonyplain and Mewassin would also reach this township, but owing to the lack of ferry facilities on Saskatchewan river in this neighbourhood it would serve to no good purpose during the flood season. The northern part of this township, that is to say, the two northern tiers of sections, has been overrun by fire, and is at present covered with fire-killed timber and a second growth of small poplar and scrub. The top soil has disappeared, leaving the clay exposed. Its surface is for the most part heavily rolling. The central zone of this township is partly open, with a few islets of green poplar of eight inches diameter. The soil is of a fairly good quality, consisting of a layer of black sandy loam overlying a clay subsoil and suitable for mixed farming, and at present produces a dense growth of wild peas in the openings. The remainder of this township, except sections 1 and 12, where conditions are more favourable, is of a heavy rolling nature and densely covered with poplar, spruce and balm of Gilead of a diameter of ten, fifteen and twenty inches, respectively. Lumbering operations have formerly been carried on on the flats of Saskatchewan river in sections 29 and 32, and the licensee contemplates cutting the merchantable timber in the southern part of the township during the course of the winter. This township though not very abundantly provided with natural hay, yet contains numerous small hay marshes scattered throughout the central zone. Numerous small creeks varying in width from two to ten feet and running in ravines of various depths with a permanent supply of good water, are to be found in this township. There are no streams of sufficient capacity to warrant the development of water-power. The climatic conditions are those generally prevailing in northern Alberta. No summer frosts were observed while the

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 3—Continued.

survey operations were being carried on (June and July). There is an abundant supply of fuel in every section, consisting of scorched poplar, balm of Gilead and large willow. A lignite vein known as 'the coal arch.' is to be seen in the cut bank of Saskatchewan river in section 29. No stone quarries and no indications of minerals of economic value are to be found in this township. The only kind of game to be seen here is black bear, and this season they have proved very troublesome by interfering with our caches.—*Louis E. Fontaine, D.L.S., 1906.*

60. This township is reached by the Dawson or Chalmer's trail which enters it on section 4 and leaves it on section 30. It is a passable wagon trail but north of Paddle river especially it requires some repairs to be in good order. The bush is too close to it and keeps it wet, muddy and soft all the time. A bridge on Paddle river is needed to avoid delays and risks when the water is high. The soil is a coat of black loam five to ten inches deep over a sandy clay subsoil which is very porous and absorbs water very fast. It is eminently suitable for farming. The surface is rolling. The two northern tiers of sections are mostly covered with small poplar and brush easily cleared. It is an old brulé over which fire passed again, last year probably, killing nearly all the new growth. Areas of that light poplar and brush are also found farther south, but on sections 16, 17, 8, 9, 3 and 4 the timber is heavy. Spruce is met with in nearly every section, but towards the north fire has killed the most of it and it is dry. There appear to be large tamarack swamps, on section 22 extending into 27; on sections 24, 25 and 26; at the corner of the adjoining quarters of sections 11, 12, 13 and 14, and a large one crossing the east outline on sections 12 and 13. I would recommend that these be reserved for the preservation of the water supply. The south half of section 16, the north half of section 9 and part of all the surrounding quarter sections are covered with a magnificent growth of spruce such as I have not often seen in this country. I would recommend that this spruce be reserved for the use of the settlers. The timber is sound and straight with an average of three logs before reaching the lower limbs. I would estimate that there is about two to three million feet of lumber in this area. The nearest stream is Paddle river, six miles south. There are a few hay sloughs but none of any extent that I know of. The water is good wherever found, and as there are no large streams in the township there are no water-powers to be mentioned. The climate is the same as in Edmonton. There is enough timber to supply the fuel for a few years, and outside of the northern sections enough timber could be preserved on each section to supply the wants of the settlers for years to come. I know of no stone quarries nor of any minerals of any kind. A large number of lynx were trapped on this township last winter, also some mink and bear. I have seen tracks of moose, deer and timber wolves. There are a few partridge, and rabbits are in abundance.—*Geo. P. Roy, D.L.S., 1906.*

Range 4.

10. The best route for reaching this township is to leave Cowley station on the Crowsnest branch of the Canadian Pacific railway, travelling north to Oldman river, and along Oldman river through the Gap, to Livingstone river. The soil is a black loam, with a sand subsoil in the flat valley of Livingstone river. It would be suitable for the growth of cereals, except for the heavy frosts in summer. The surface of the valley of the Racehorse branch of Livingstone river is prairie with a few spruce, pine, poplar and scrub. The pine measured up to eight inches on the southern slope of the valley. The open prairie of the valley has a good quality of hay. The water is fresh and the supply sufficient and permanent. The size of this stream is one-third the discharge of Livingstone river. The land is not likely to be flooded. This stream is almost a continuous rapid with a good deal of apparent water-power, but it would be difficult to dam the stream. The climate is very dry. The inhabitants say there is frost every week, with the exception possibly of one or two weeks in August . Fallen

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 4—Continued.

timber on the mountain and hillsides would afford fuel. In section 23 there is an outcrop of bituminous coal which probably runs north the extent of this township, and from the south edge of the valley appears to continue south. The coal in this township, and in the two townships immediately north of it, seems to lie on a line almost due north and south. There are no stone quarries or minerals. Game consists of a few prairie chicken, partridge, antelope, mountain sheep and bear. The fish in Racehorse river are very plentiful.—*A. L. MacLennan, D.L.S., 1906.*

11. The best route for reaching this township is to leave Cowley station, on the Crowsnest branch of the Canadian Pacific railway, travelling north to Oldman river through the Gap of Livingstone river. The soil is a black loam covering sand in the flat valley of Livingstone river. It would be suitable for the growth of cereals, except for the heavy frosts in summer. The valley of the northwest branch of Livingstone river is a narrow prairie bounded by the mountains on either side, timbered with spruce and pine. The pine is from six to ten inches in diameter, except in the valley of the northwest branch. In the valley of the northwest branch there is a good quality of hay. The water is fresh, and the supply is sufficient and permanent. The northwest branch is a very rapid stream, about one-third the volume and discharge of Livingstone river. The land would not be subject to floods. The northwest branch is practically a continuous rapid, but there is no available horse-power, as it would not be convenient to construct dams. The climate is very dry. The inhabitants say there is frost every week, with the exception possibly of one or two weeks in August. Fallen timber on the mountain and hillsides would supply fuel. In the centre of section 35 there is an outcrop of bituminous coal; which would probably extend to the north and south, through the length of this township. Also in the centre of section 14 there is an outcrop of bituminous coal. There are no stone quarries or minerals of economic value. The game consists of a few partridge and prairie chicken, antelope, mountain sheep and bear. The fish in the northwest branch is abundant.—*A. L. MacLennan, D.L.S., 1906.*

12. This township is similar to township 12, range 3, west of the fifth meridian. —*A. L. MacLennan, D.L.S., 1906.*

22. There is a good trail from Calgary to Priddis post office, a distance of about twenty miles. From there it is about four miles west over a rough, somewhat swampy trail to the east boundary of this township. From Midnapore, a station on the Macleod extension of the Calgary and Edmonton railway, it is about twenty miles. A fair winter trail runs up to about section 18 up the valley of Fish creek, but that portion that is boggy in summer is generally glare ice in winter before the snow falls. The soil generally is a black loam with clay subsoil, but it is frequently stony and rocky on the more elevated places. It produces fine pasture and good hay in the more open parts. For raising crops, I consider the climatic conditions most unfavourable. The surface is hilly and rolling, with but a small proportion of open prairie. The rest of the surface is covered with scrub—willow and second growth poplar—and some timber. The bunches of timber, yet standing, consist of spruce and banksian pine. The most important of these bunches are found on the south half of section 12, the south half of section 2, the northwest quarter of section 11, the east half of section 10, the east half of section 4, the northwest quarter of section 4, the northeast quarter of section 5, the southeast quarter of section 8, the northwest quarter of section 16, the southeast quarter of section 21, the west half of section 15, the northwest quarter of section 16, the southwest quarter of section 14, the southwest quarter of section 11, the southwest quarter of section 22, and the southwest quarter of section 21. Hay has been cut in various places along the valley of the south fork of Fish creek, more particularly on sections 11 and 12, and on sections 17 and 18 on the south side

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 4—Continued.

of the creek. This creek enters the township in section 18 and leaves again in section 12, flowing through a valley, which traverses sections 18, 17, 21, 22, 15, 14 and 12. It averages about twenty-five links in width and one foot in depth. Since it rises in the mountains, it contains a good quality of water. Another little stream called Whiskey creek crosses the southern tier of sections through a narrow valley partly timbered and partly covered with scrub. The north branch of Fish creek runs diagonally, southwest through sections 35 and 25. Besides these creeks numerous springs take their rise in the hills, and are the cause of so many swamps. The climate is not favourable for farming purposes, frosts occurring from time to time during the summer months. As far as I could learn, no attempt has been made at cultivating the soil. There is but one settler in this township. He has a house, a stable and some pasture land fenced in. He has some horses but no cattle. There are two winter cow camps, where outside ranchers cut hay and feed it to their young stock. The one situated in the northeast corner of this township I have no personal knowledge of; the other one is situated on the northeast quarter of section 18, where there is a good log house, a large log barn and a small amount of fencing. About a half dozen large hay stacks were seen here. A peculiar looking small animal was also observed here. It appeared to be domiciled under the floor of the log shack, and made considerable depredations at night among my provisions. When caught, it proved to be what is locally called a mountain rat. It had a bushy tail and large, erect, almost round ears. For fuel, any quantity of fire-killed standing timber is available. No indications of coal were observed, and no stone quarries or other minerals of any economic value. Partridge and rabbits appear plentiful, and there are also some grouse. Many deer tracks in the snow were also observed. The deer will probably be exterminated before many more years, as this part of the district is part of the hunting grounds of the Stony Indians. Trout of many varieties are said to be plentiful in the south branch of Fish creek. An Indian pack trail from Morley, a town on the Canadian Pacific railway, situated on the Stony Indian reserve, runs southwest through this township, and then south for quite a long distance. It it not suitable for wheels, but a good sleigh road might be constructed along it for winter travel, when conditions make such necessary.—*C. F. Miles, D.L.S., 1906.*

56. This township is reached by means of a trail which leaves Peace river road in township 56, range 2, opened by the surveying parties who were engaged on the preliminary surveys of the Transcontinental railway. The trail is in a very bad condition owing to numerous muskegs and swamps which have to be crossed and there are no bridges nor log crossways, so that persons teaming over the road have to spend much time brushing to make the trail passable when not frozen. The soil is a dark loam overlying a clay subsoil, and seems to be a good fertile soil suitable for all kinds of crops. The surface is rolling and covered with timber or scrub. Much of the timber attains a good size, poplar running up to fifteen inches and spruce up to twenty inches in diameter, apparently thrifty when not killed with fire. There is some white birch scattered through the poplar. More or less spruce is seen all through the township but the bulk of the timber is in the south half, and west of Oldman lake. About half of the surface has been burned over and a large proportion of the timber is dead and some of it fallen. Fire has recently overrun the north part of the township but has not done as much injury as former fires. There is little hay to be got without clearing the flats and marshy places, but there is some around the south end of Oldman lake and in spots along the creek which joins this lake at the south end. Water is abundant in ponds and small streams tributary to the creek which flows into the lake. All water is fresh and good. There are no millsites nor water-powers available. A small fall could be made by building a dam across the creek in many places, but the water supply would fail in dry weather. The climate seems favourable, with few indi-

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 4—Continued.

cations of summer frosts. Wood for fuel, of the best kind is abundant everywhere, but there are no indications of coal. The township is free from rock outcrop and but few boulders are to be seen. There are no minerals of any description visible. Game is scarce; there are a few bears, wolves and foxes, with an occasional small deer. During spring and fall there are ducks in Oldman lake and some fish, consisting of pike, doré and goldeyes There are no settlers in the township at present but quite a settlement four miles farther on in Pembina valley locally known as 'Wild Horse valley.' The preliminary survey line of the Grand Trunk Pacific enters this township in section 24, and leaves it in section 35.—*Thos. Fawcett, D.T.S., 1906.*

57. Access to this township is gained by means of a trail opened by the surveyors in charge of the Grand Trunk Pacific railway preliminary surveys, it enters the township in section 5, and leaves it in section 18, following closely the surveyed line of the railway across the southwest corner of the township. The trail when not frozen is in very bad condition. The soil generally is a clay loam except near Pembina river, where it is sandy and the subsoil usually clay. All the elements needed in a fertile soil seem to be present. The surface is rolling to hilly and the whole covered with timber or brush and on that account would scarcely be recommended for settlement. The greater portion would be worth preserving for a timber berth as there is much valuable spruce of considerable dimensions. Two-thirds of the township next the north boundary might be set aside for a timber berth (except sections 18 and 19). There are squatters in sections 6, 7 and 19. For two miles lying north of the south limit of the township, poplar is the predominant timber, with thick scrub and isolated patches of spruce and tamarack. Portions of the township, probably one-fourth of the entire area, have been overrun with fire four or five years ago and much of the timber destroyed. There is excellent spruce in the vicinity of Pembina river varying in size up to 36 inches in diameter, and cottonwood up to forty inches. I would estimate the merchantable spruce at 12,000,000 feet, board measure, besides other valuable timber. There is some hay in sloughs formed through changes in the river bed, but in no large quantities. Water is abundant and good in all parts of the township. The north end of the township is principally muskeg saturated with water to the surface of the ground and boggy everywhere the timber is large. There are no falls on the river or rapids worth noting although the current is strong during periods of high water. Climatic conditions seem favourable, there being no indications of summer frosts or injury therefrom. The wood supply for fuel is everywhere plentiful, but no indications of coal were seen except small fragments washed up by the stream along the banks of the river. No minerals of economic value were seen nor rock valuable as building stone. Game seemed scarce, consisting of small red-deer and occasional bears, foxes and wolves. The river seemed well stocked with fish, consisting of pike, doré and goldeyes.—*Thos. Fawcett, D.T.S., 1906.*

58. The means of access to this township is a trail cut from the Edmonton-Peace River trail some seven years ago by a Mr. Menier, who resides on section 33. The road is in fairly good condition during the dry season of the year. Both clay and sandy soil are found in most sections, with usually a clay subsoil suitable for growing either grain or root crops. The south half of the township is heavily wooded, while the north half is timbered with poplar and scrub or open scrub brulé. The south half of the township, owing to the presence of several large muskegs or floating bogs, is scarcely suitable for settlement, but contains some good timber, spruce, tamarack, poplar, &c., and might be set apart for a timber berth. There would easily be over 100,000 feet board measure of merchantable timber on each section of 640 acres, or an estimate of 2,000,000 feet would not be too great for the south half of the township. There are a few hay sloughs scattered over the north half of the township, but

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 4—Continued.

none of large dimensions. The water is fresh and abundant in ponds and lakes. There are no streams except a few gulches which carry off surplus water in the spring and during periods of flood. Garden produce and grain are grown successfully, as seen on squatters' claims, with no more liability to summer frosts than elsewhere. Wood for fuel, dry poplar, spruce, tamarack, &c., is plentiful. No indications of coal nor minerals of any kind were seen nor any outcrop of rock. Game seemed to be scarce. Ducks settle in the ponds and lakes during spring and fall, but few seem to breed there. Wolves hover around the settlement. Rabbits are plentiful, and supply both wolves and foxes with food.—*Thos. Fawcett, D.T.S., 1906.*

59. Access to this township is open from the south by means of a trail which branches off from the trail crossing township 58, range 4, in section 36, also at the northeast corner of the township, where a branch from Peace river trail enters the township. Both roads are passably good in favourable weather. The soil is generally a sandy loam with subsoil of clay, and is well adapted for producing any kind of crops. The surface is undulating, with some considerable hills, and covered with timber or scrub. The greater part is brulé overgrown with brush. Nearly every section contains patches of green timber which escaped destruction when the fire ran over the country. These green patches are usually protected by muskegs which are numerous in all parts of the township. While there is plenty of good timber for all purposes of settlement and some very valuable spruce, yet not enough to justify withholding the land from settlement, as there are portions of every section that can be easily cleared of brush and ground timber and made ready for the plough. Considerable hay may be obtained from marsh meadows, especially after improvement. Water is easily obtainable in all parts and is of good quality. The choice locations, with water as a prime object, are on Paddle river which enters the township in section 6, and after following a winding course emerges in section 13. The stream, which averages a chain in width, is from three to ten feet deep and contains excellent water, and seems fairly well stocked with fish. There are no falls nor rapids worthy of note on this part of the stream. Climatic conditions seem favourable, with few indications of injury from frost. Garden produce was mostly green up to the middle of September. Wood for fuel abounds in large quantities all over the township. No indications of coal or other minerals of value were observed, nor did we see any outcrops of rock suitable for building purposes. Ducks are found in the lakes and ponds during spring and fall; partridges and chickens are present but scarce. Wolves seemed rather numerous, and foxes also make their home here. The greater part of this township is adapted for settlement.—*Thos. Fawcett, D.T.S., 1906.*

60. This township is reached by the Chalmers or Dawson trail which enters on section 25, and then running northwesterly leaves it by crossing the north boundary of section 34. It is fairly good in dry seasons, but in the spring and after the June rains it was hardly fit to travel. The soil is a coat of black loam averaging ten to twelve inches deep over a sandy clay subsoil eminently suitable for farming. The surface is rolling. The eastern half is covered with a new growth of poplar one to three inches in diameter, with bluffs of large size as well as groves of spruce around the edge of the sloughs. There is a sufficient quantity to supply the first wants of the settlers. The western half of the township, especially sections 18, 19, 28, 29, 30, 31, 32 and 33 are heavily timbered with a fine growth of large spruce. About two million feet of lumber could be cut in each of these sections besides seven or eight thousand cords of pulpwood. There is no stream going through this township sufficiently large to drive lumber. Hay sloughs are not numerous but a good quantity of hay could be cut around the lakes in the southwestern part. The water is good wherever found, but there are

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 4—Continued.

no large streams nor water-powers that I know of. The climate is the same as in Edmonton. I have seen no stone quarries nor minerals of any kind. There is sufficient timber on every section to supply fuel for the first wants of the settlers and in most sections to supply the wants for years to come if properly cared for. We have seen tracks of bears and deer. Rabbits are plentiful and lynx are trapped all over the township. Ducks were thick in the lakes, but partridge and chickens were scarce.—*Geo. P. Roy, D.L.S., 1906.*

Range 5.

50. This township is accessible by a good wagon trail from Edmonton via Mewassin. The township presents a very rough appearance owing to the high rough banks of Saskatchewan river valley which passes through it. Owing to this roughness and also to the fact that the black loam covering it ranges in depth only from three to five inches with a subsoil on the higher places of clay and in the valleys of sand, this township is not suitable for agricultural purposes. Moreover the scarcity of hay and the presence of muskegs in the northerly portion are other features which spoil it for the farmer. One commendable feature is the presence of good water though there are no water-powers; another is the beauty of the climate which closely resembles that of the Edmonton district. In the southwesterly portion of the township, spruce timber up to two feet in diameter, and of a second grade quality, is found, a goodly portion of which has been cut and was being cut at the time of the survey. Also throughout the township poplar trees abound which are and will be the chief supply of fuel, though there is a likelihood of coal being discovered in the near future. Regarding stone quarries and minerals of economic values there are none, and the game found is of no consequence.—*R. H. Knight, D.L.S., 1906.*

57. The best route for getting to this township is by means of the Grand Trunk Pacific wagon road which runs from Sion to McLeod river. This trail enters this township in section 13 and runs approximately due west, keeping south of Pembina river as far as the east boundary of section 18 where it crosses over a good ford, and thence keeps along the north bank of the river, finally leaving the township in section 18. The part of this trail south of the river is very hilly and not at all good. From this trail, at Logan's store in the northeast quarter of section 13, where there is a good crossing over Pembina river, a settler's trail runs north to Morris' farm in section 26, from where I cut a road running approximately due north. This road runs as far as the trail from Peavine prairie to Belvedere in the south of township 59, range 5. I also cut another road from Morris' farm in section 26, which runs westerly through sections 26, 27, 28, 29, 20, 19 and joins the Grand Trunk Pacific Railway trail, first described, in section 18. The soil in this township is not first-class, consisting generally of three to four inches of black loam over a hard clay subsoil and can mostly be rated as second class land, suitable for mixed farming. In sections 5, 6 and 7 there is some first class land and along Pembina river, the flats have a rich deep soil, averaging from six to twelve inches of black loam over a sandy loam subsoil, which is suitable for all kinds of crops. The surface is generally undulating in character, and is covered with poplar and spruce, averaging from four to eight inches in diameter. About one-half of this township has been burnt over and is covered with brulé, windfall and willow brush. There is very little timber in this township, but some large spruce, averaging from ten to twenty inches in diameter, is to be found along Pembina river, especially on the south side and in small bluffs all through the township. There are no large hay meadows, but small ones are scattered all through the township. All the water in this township is fresh, and the supply is sufficient and permanent, being furnished by Pembina river which averages two hundred and eighty feet in width, two feet in depth, and has a current of three miles an hour; by Coyote creek which averages twelve feet

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 5—Continued.

in width, one foot in depth and has a current of one mile an hour, and by a permanent lake in sections 34 and 35. No land is liable to be flooded. There is no natural water-power available, but Pembina river could be dammed so as to furnish power. The climate is similar to the Edmonton district. Wood for fuel is available on every section. No coal veins have yet been discovered, but there is considerable float coal in the bed of the river and possibly coal will be found in this neighbourhood. There is no stone or mineral. There is not much game, but there are fish in Pembina river, namely, pike, perch and goldeye.—*Reginald H. Cautley, D.L.S., 1906.*

58. There are two routes for reaching this township, viz.: by the wagon trail which runs from Belvedere to Peavine prairie, which is a good trail and runs through the north half of sections 34, 33, 32 and 31 of this township; and by the Grand Trunk Pacific wagon trail which runs to McLeod river and follows the south bank of Pembina river through township 57, range 5, from this trail at Logan's store where there is a good crossing over Pembina river, a wagon trail runs as far as Morris' farm in section 26, township 57, range 5 from which I cut a wagon trail, running practically due north, through sections 2, 11, 14, 23, 26 and 35 of this township to meet the trail first described, in section 1, township 59, range 5. From section 11 in township 58, at the northwest corner of a lake which the trail follows, I cut a short trail running due west, which follows the north boundary of sections 10 and 9 as far as the northeast corner of section 8. The soil in this township is not very good, consisting generally of two to three inches of black loan over a sandy clay subsoil, and would not make first class farming land, although all of it is suitable for mixed farming. The surface is generally undulating in character and is covered with poplar four to eight inches in diameter with some spruce and tamarack four to eight inches in diameter in swampy places. Nearly one-third of this township has been burnt over by bush fires and is covered with brulé and windfall with poplar and willow underbrush. Along Paddle river there is usually a strip averaging a half mile in width of marshy flat, covered with gray willow and willow brush. There is very little valuable timber in this township, although there are occasional large spruce scattered through it. There are several small hay meadows along Paddle river, but none of any size. In the south half of section 25 along a small creek valley, probably fifty or sixty tons of hay could be cut, and there are occasional small hay meadows scattered all through this township. All the water in this township is fresh, and the supply is sufficient and permanent, being furnished by Paddle river, which averages thirty feet in width, two feet in depth and has a current of two miles an hour, and which flows through sections 35, 34, 27, 28, 29, 30 and 31. The water is also supplied by eleven permanent lakes. The banks of Paddle river are very steep cut and average fifteen feet in height and no land is liable to be flooded. No water-power can be developed. The climate is similar to that in the Edmonton district. Wood for fuel can be obtained on every section, but no coal or lignite has been found. There is no stone or mineral and no game.—*Reginald H. Cautley, D.L.S., 1906.*

59. The trail from Belvedere to Peavine prairie, which is a good trail, passes through sections 1 and 2 of this township and then runs approximately due west, keeping about one-quarter of a mile south of the correction line. From this main trail, in the northwest quarter of section 1 there are two other trails branching off; one running approximately north and keeping near the east boundary of the township; and the other running in a northwesterly direction along a creek valley as far as the central meridian which it continues to follow very closely. Both these trails were cut by myself, and run into township 60. The soil in the east half of this township is good, consisting of eight or nine inches of black loam over a clay subsoil and is suitable for raising all kinds of crops; but in the west half the soil is very light, consisting of three inches of black loam over a sandy clay subsoil, and is very stony in

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 5—Continued.

places. It would not be suitable for raising crops, but would make a fairly good range country. The surface in the east half of the township is undulating in character, but in the west half it is broken or steeply rolling in character. The whole township was evidently at one time timbered with very heavy spruce, but this has nearly all been destroyed by fire. Now there is windfall overgrown with poplar and willow brush over nearly all the township, but bluffs of spruce and poplar are to be found scattered all over the township. There is not much timber in this township, but small bluffs of spruce averaging from six to eighteen inches in diameter are scattered all over it. There is not much hay in this township, but probably one hundred tons or more could be cut along the big creek which flows through the centre of this township. All the water is fresh and the supply is sufficient and permanent and is furnished by two fairly large streams and six permanent lakes. The two streams are as follows, viz.: Paddle river, which flows through sections 12, 1 and 2, and is forty feet wide, two feet deep and has a current of two miles an hour; a large creek which flows south, through the centre of this township, into Paddle river and averages fifteen feet wide, eighteen inches deep and has a current of one mile an hour. The lakes are situated as follows: in sections 36 and 35; Swan lake in sections 19, 20, 29 and 30; in sections 15 and 16; in sections 17 and 18; in section 7 and in sections 3 and 4. Of these, Swan lake is a very fine lake with deep water and sandy shores and contains jackfish, but the others are shallow lakes with marshy edges. There is no water-power available. The climate is similar to that of the Edmonton district. Wood for fuel is available on every section, but no coal or lignite has been found. There is no stone suitable for quarrying and no minerals have been discovered. There is no game.—*Reginald H. Cautley, D.L.S., 1906.*

60. There are no good trails through this township, the only ones being those cut by myself. There are two ways in which this township can be reachel from Belvedere on Pembina river. Firstly, by means of the Klondike (or Swan Hills) trail, from which I cut a wagon road approximately due south to the northeast corner of the township, whence it continues approximately due south; secondly, by means of the Grand Trunk Pacific wagon road to Peavine prairie, which crosses the southeast corner of township 59, range 5; in about the middle of the northeast quarter of section 1, township 59, range 5, there are two trails branching off this main trail, one running due north (approx.) being the continuation of the trail first described, and the other running in a northwesterly direction along a creek valley until it reaches the central meridian of township 59, along which it runs almost due north, although keeping to the west of the meridian after once crossing it; this trail runs as far as the middle of the northeast quarter of section 16, township 60, range 5, but is not as good a trail as the one keeping to the east boundary of range 5. The soil is good as a rule, being composed of four or five inches of black loam over a sandy loam or sandy clay subsoil, and if the land is cleared should prove suitable for all sorts of mixed farming. The surface is very broken in the centre of the township, but as a rule is gently rolling in character and for the most part is heavily timbered with spruce averaging from eight to twenty-four inches in diameter with some poplar, cottonwood, tamarack and birch averaging from six to eighteen inches in diameter. There is a great deal of muskeg and swamp in this township, especially in the northern part, covered with spruce and tamarack averaging from three to eight inches in diameter and there is also considerable land in the north and south parts of the township covered with brulé and windfall overgrown with small poplar. There is good spruce timber averaging from eight to twenty-four inches in diameter with some poplar, cottonwood, tamarack and birch timber averaging from six to eighteen inches in diameter to be found in nearly every section in this township, although in the extreme north and south portions it has mostly been destroyed by fire. There is very little hay in

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 5—Continued.

this township, the only place in which some was found being on the edge of the two lakes on the east boundary of section 14, where in dry seasons about one hundred tons could be made. All the water in this township is fresh and the supply is sufficient and permanent, being furnished by several small creeks and seven permanent lakes. One of the creeks flows through sections 6 and 5, and is twelve feet wide, one foot deep, and has a current of two miles an hour. The lakes are situated as follows: in sections 34 and 35; in sections 22, 27 and 28; in sections 14, 15, 22 and 23; in sections 13 and 14; in sections 1 and 12, and in sections 1 and 2. No land is liable to be flooded. No water-power can be developed. The climate is similar to the Edmonton district, but more liable to summer frosts owing to the presence of large muskegs. Wood for fuel is procurable on every section. There are no stone quarries, minerals or coal veins. There are some moose and deer.—*Reginald H. Cautley, D L.S., 1906.*

Range 6.

8. *Sections 1 and 2.*—A narrow timbered valley runs southeasterly through section 1, the timber being mostly jackpine and spruce up to eight inches in diameter. A good creek runs northerly through this valley. The east half of section 2 is broken by a mountain which is covered with spruce timber. A good wagon road leading into Crowsnest passes through section 1. The fuel is wood and can be procured on those sections. No hay occurs on these sections nor any water-powers. No game and no traces of minerals were found. The soil is a sandy clay in the valley, and mostly bare rocks on the side-hills. The climate is very changeable and summer frosts occur. Plenty of limestone rock can be quarried on these sections.—*Lennox T. Bray, D.L.S., 1906.*

50. *Portion south of Saskatchewan river.*—This portion of the township can be reached by a trail recently constructed by lumbermen, which enters the township along the south side of Saskatchewan river. This trail crosses the river about fifteen miles eastward. There is a good trail on the north side of the river which is an extension of the Mewassin trail from Edmonton. The portion of land included in this report is exceedingly rough and broken and is quite unsuited for agricultural purposes. The whole is covered by bush which varies in size up to two feet in diameter, with a scrub undergrowth in all parts of the township. The large timber is chiefly spruce, of a second grade quality. A considerable quantity of this had been cut and what remained was being cut at the time of survey. There is no hay to be seen, but a sufficient supply of good water is to be had. There are many ravines to be found adjacent to Saskatchewan river, all of which contain small streams of good water. There are no water-powers on the above mentioned river, but along its banks can be seen good sandstone. None of this stone has yet been quarried except on a small scale for testing purposes. The stone is good and can be transported down stream very cheaply to the towns and cities located along or near the said river. The climate in this vicinity is good, being about the same as that of the Edmonton district. Frosts did not occur during the time of survey. Minerals of economic value are not apparent, neither is there any game worth mentioning.—*R. H. Knight, D.L.S., 1906.*

50. To reach the work was an easy matter, as a wagon road runs from Edmonton, some seventy-five miles west. The surface of the ground in this township is fairly level until nearing the river, where it is rolling, and contains a fair amount of non-merchantable timber, consisting mostly of scattered poplar—a heavy underbrush of scrub poplar and willow—and a narrow fringe of spruce along the river. The soil would be most suitable for mixed farming, being a clay subsoil with about four inches of good black loam. Hay is very scarce, although good grazing is to be had during

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 6—Continued.

the summer. No lakes occur, but water is reached at a short depth; sloughs were shallow and dry. Big creek, in the northwest corner of the township, is the only stream of any importance. It is some twenty-five feet in width and about five feet in depth at high water. It is so tortuous and uncertain in supply that it could not be looked upon as being of any use commercially, for water-power, log driving, &c. The climate as indicated by the growth is good and frost during the summer is only occasionally experienced. Fuel is abundant in the shape of firewood, and the likelihood of coal is shown by the quantity of float in Big creek along which are posts driven and marked 'Coal Claims.' No seams were seen, but it is generally known that there is an abundance of coal in the locality. Along the river running through this township large outcroppings of sandstone were to be seen in several places, some of which are about to be developed. There are no minerals. Game of all kinds is to be had, from moose to prairie chickens.—*A Driscoll, D.L.S., 1906.*

51. *Southern part.*—This township is easily reached by a good trail from Edmonton via Mewassin. The portion of land herein reported upon is quite level, but yet is of little value in the near future for agricultural purposes, on account of the numerous swamps and muskegs. These swamps and muskegs are generally covered with small spruce timber up to six inches in diameter, which is frequently dead. The higher and drier portions of land have upon them a growth of poplar up to six inches in diameter, with an undergrowth of willow scrub. Hay is scarce, so also is good water, though there is plenty of surface water of a poor quality obtainable from the swamps. The only fuel consists of the wood mentioned above, but undoubtedly there is at a moderate depth large coal areas which are common to the surrounding country. There are no stone quarries, neither are there apparent any minerals of economic values. There are no water-powers. The game in this portion of the country is of no consequence. —*R. H. Knight, D.L.S., 1906.*

55. The township is crossed by the road from Lac Ste. Anne to Paddle river. I have not travelled over the road, but I hear that it is hardly in good enough condition to allow wagons to go over it. The soil consists generally of black loam with a subsoil of clay or sandy clay. Stones are found only in a few pits. The soil is very good for farming. Almost all the quarter sections would rate either as class No. 1 or 2. The township is covered with poplar and willow. There are a few open spots in the eastern part. Spruce is scarce. There is no timber of consequence in the township. Jackpine is found only in a couple of spots. Spruce is found in several places, but only in small quantity, and always mixed with poplar. Most of it is less than 9 inches in diameter. As the township is timbered there are but few spots where hay is found. On sections 9 and 21 some hay could be made, though not many tons. The water is not alkaline. In some lakes (Prefontaine and No. 2) it is not fit to drink. There is no stream of importance. The biggest creek comes from the southeast and empties into lake No. 2. No water-power is available. The climate is something like that of Edmonton, I presume. The coldest recorded was 49° below zero, on January 26th, 1906. The fuel most readily available is dry wood. It is quite plentiful. There are no coal veins known to me. There are no stone quarries or minerals. Deer and bear would probably be found in the township.—*Raoul Rinfret, D.L.S., 1905.*

56. The township is crossed by the road from Lac Ste. Anne to Paddle river. I understand that it is hardly in good enough condition to allow of wagons to travel over it. The soil is very good for agriculture. Three-fourths of the sections would rate as class No. 1. Gravel and stones are met with occasionally in the pits. The soil consists of black loam with a subsoil of clay or sandy clay. The township is well covered with timber which consists of big poplar and willow. There is birch

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 6—Continued.

scattered here and there. Spruce is scarce in the township. Some is seen along Deep creek in some spots, and in the southeast corner of the township. There is very little hay to be made. The only place where hay is found is between lakes Kelly and Hope, and in small quantity. The water of lake No. 1 is not fit to drink. The only creek of importance is Deep creek, which is the outlet of lake No. 1. There is another creek running northerly in the northeastern part of the township. Deep creek, on the east boundary of section 25, township 56, range 7, is 25 links wide. It was dry in January. The climate would probably be like that of Edmonton. The coldest recorded by me was 49° below zero. Dry wood is very readily available. There are no stone quarries or minerals. Deer and bear would probably be found. The township is fairly level, except the western part. The Grand Trunk Pacific is expected to pass a few miles north of this township.—*Raoul Rinfret, D.L S., 1905.*

57. This township can be reached by the road running to McLeod river, which crosses range 6 approximately along the correction line, and by going from there southward across township 58 by our road. It can also be reached by the south branch of the McLeod road, which runs along Pembina river, but this road across range 5 is practically impassable. The soil as a whole is good, especially along Pembina river, where it is black loam top soil and sandy loam subsoil. On the high ground there is a clay subsoil. It is suitable for raising grain and vegetables, and some of the new settlers obtained good crops of both this season. The surface is level as a whole, though there are various well-defined valleys, but the change is not abrupt except in places along Pembina river. The surface is completely wooded. Originally the timber was spruce of large size, but this has been burnt to some extent, and it is now mainly covered with poplar three to twelve inches in diameter. The original timber shows either as standing dead timber, or as thick deadfall, and making a road through it entailed a great deal of work. South of Pembina river the timber is spruce, poplar and tamarack, most of which is of small size, and it is principally green. There are a few meadows along Pembina river and also on the high land, but hay is scarce. The water is fresh and wholesome. There are various small ponds and minor creeks, but the latter dry up in the fall, and at that season it was difficult to find water. Pembina river is the permanent stream. It is about four chains in width and from three to twelve feet in depth, depending upon the season, and it has a current of about three miles an hour. It runs in a well-defined valley, and I judge that the adjacent land is not flooded, or if so, it is only temporarily from ice jams. No water-powers exist, but they could possibly be developed along this river. The climate is favourable, and no summer frosts were observed. Timber fuel is plentiful, but no coal was discerned, nor were other economic minerals observed. Ducks, rabbits and grouse are plentiful, and the fishing in Pembina river is good.—*Thos. Drummond, D.L.S. 1906.*

58. The best route for reaching this township is by a road leading to McLeod river which crosses range 6 approximately along the correction line, and thence southward by a road cut by my party. The soil consists of the usual covering of black loam, and the subsoil is usually clay, except when it is a sand or sandy clay, which is presumably underlaid by the clay. The township is covered with timber, which is somewhat small and scrubby. As a whole it is poplar, but spruce occurs in clumps, and is scattered through the poplar. There is also quite a lot of meadow land covered with thick willow. Several good hay meadows were found in this township, notably around Twin lakes and in sections 15 and 16, and along Paddle river and the various creeks. This is practically all overgrown with willow, but by clearing, a large area of good meadow land could be obtained. A peculiarity of this land is its hummocky nature, which is probably due to the action of frost and heat in forming cracks in the clay soil. The grass is locally known as blue joint and it is of good quality. It

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 5—Continued.

might be added that cattle do well in this country, but it is apparently not so favourable for horses. This township is suitable for ranching. There is an abundance of good water throughout the township. There are quite a number of large lakes and several large streams of a permanent character. Paddle river is the principal branch of Pembina river. It traverses the township in a northeasterly direction, is about sixty feet in width and from two to twelve feet in depth, and has a current of about three and one-half miles an hour. Southeast of this stream and about one-half mile distant from it is a parallel stream which I consider runs in an old bed of Paddle river. It is about seventy feet in width, from five to ten feet in depth, and has very little current. A creek joins Paddle river from the north side in section 15; it is about twenty feet in width and from three to five feet in depth and has a current of about two and one-half miles an hour. One branch of it runs through Chip lakes, and the south branch runs eastward from the adjoining township. Along all of these streams the adjoining meadow land is flat and low, and it is probably flooded more or less in the spring freshet, but to what extent and depth I cannot state. Wood fuel is plentiful everywhere, but coal was not discovered, nor were other economic minerals observed. Ducks, geese, grouse and rabbits are plentiful, and there are pike and other fish in the streams, and in several of the lakes.—*Thos. Drummond, D.T.S., 1906.*

59. The route to reach this township is by a road going to McLeod river. It is in bad condition, as it crosses various muskegs and streams. To make it passable I had to corduroy several muskegs, and build various bridges, one of which crosses Paddle river, and has a span of about sixty feet. This road crosses range 6, approximately along the correction line, and our own road runs northward from it across the township. The soil is very good, and it is suitable, I should judge, for raising the various grains and vegetables. It consists of black loam top soil and a clay subsoil. This clay land, I judge, would make good wheat land, as there is a rank growth of peavine in the poplar land. The surface is covered with timber, spruce, tamarack, birch and willow. One portion, i.e., the greater part of sections 16, 17, 18, 19, 20, 21, 28, 29 and 30, is included in timber berth No. 1191, and consists of spruce of large size and good quality. Most of the remaining part of the township is covered with poplar, three to ten inches in diameter. The surface is rolling, and in many places quite rough and hilly. Swamp hay of good quality, and in considerable quantity can be obtained along the shores of Thunder lake and Twin lakes, and also along a creek which runs in a southeasterly direction, across the southwestern part of the township. The water is quite fresh and wholesome. There are many lakes, some of which are of considerable size, in which the supply is permanent, and there are also various creeks, which are not as permanent in the fall of the year. Some of the meadow land along the creeks is probably flooded for a short time in the spring, to a depth of perhaps one foot. No water-power exists, and none could be developed. The climate seems favourable, and no summer frosts were observed. Wood fuel is plentiful everywhere, but no coal or other economic minerals were discovered. The various waterfowl are plentiful, also rabbits, and some of the fur-bearing animals, and in the fall of the year Indians killed three moose in the township.—*Thos. Drummond, D.T.S., 1906.*

60. The best route to this township is by a branch of the road leading to McLeod river, which approximately follows the correction line across range 6, and thence northward by a road cut by my party. The soil is good. It consists of the usual covering of black loam, with a subsoil of sandy clay, underlaid at a greater depth, presumably, by the usual clay subsoil of the country. The timber is heavy, however, and there are quite a number of muskegs. The soil is suitable for growing the various grains and vegetables. The surface is fairly level as a whole, except along the northern part of the township, where it becomes somewhat rugged and rough, as it rises to the height of land, between Athabaska and Paddle rivers. Timber con-

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 6—Continued.

sisting of spruce, tamarack and poplar, is found all over the township. The spruce is of large size; many trees two to three feet in diameter were cut, and it is of good quality, straight and clear of branches. Timber berth 1191, a survey of which has been made by the owners, includes a large portion of this township. In the remainder of the township the timber has been destroyed by fire, and it is now more or less overgrown with poplar. Hay is very scarce throughout the township. A little can be obtained along a creek which traverses the southern part of the township. Apart from this we could find none, not even feed for our horses. The township is fairly well supplied with fresh water by various lakes of considerable size, and by several streams. The lakes are permanent, but the creeks practically dwindle to nothing in the fall and winter. There are no water-powers and none could be developed. The climate seems favourable, and no summer frosts were observed. Timber fuel is plentiful and can be procured everywhere, but no coal was discovered. No minerals of economic value were found. Moose and bear seem plentiful, and the same remarks apply to geese, ducks, rabbits and grouse, and the various fur-bearing animals.—*Thos. Drummond, D.T.S., 1906.*

Range 7.

56. This township is covered with a heavy growth of timber, consisting of poplar five inches to twelve inches in diameter and spruce four inches to fifteen inches in diameter, except parts of sections 31, 32, 33, 34, 35, 36, 28 and 27, over which the fire has run, leaving only a few bluffs of green poplar, with a new growth of small poplar and willow brush. These are good farming sections. The balance of the township is too thickly wooded for immediate settlement. A pretty good wagon trail from Lake St. Anne to Paddle river crosses sections 31, 32, 33, 34, 26 and 25. Pembina river flowing north crosses sections 4, 9, 16, 15, 22, 27, 23, 26, 35 and 36. This township is well watered by numerous creeks. The land is about level on the west side of the Pembina and rolling on the east side. It is a good second class land. There is good fish in the river, but I did not see any game in the township. There are good seams of coal all along the Pembina, which is also running a little gold.—*A. Michaud, D.L.S., 1905.*

57. *East and north outlines.*—Pembina river is crossed in section 1, along which there are small areas of prairie to the west. Sections 1, 12, 13, and the south half of section 24, are densely timbered with poplar from four to eight inches in diameter. The height of land between Pembina and Paddle rivers is about the centre of the north half of section 12. From there the land slopes gradually to the northwest. The bottom lands are reached about the middle of section 24; from here to the northeast corner of section 36 the land is low and wet with willow scrub and grass sloughs. Paddle river, a stream about thirty-five links wide, three feet deep, with slow current and mud banks from six to eight feet high, flows in a northeasterly direction crossing the east outline about the middle of section 25. The north outline is mostly on the south slope of a range of hills separating Paddle river from another stream flowing across township 58. The north boundary of section 36 is swampy, with willow scrub and sloughs. The east half of section 35 is covered with green poplar, from three to six inches in diameter; the remainder of the outline is rolling and runs through old brulé grown up with poplar and willow scrub. An old pack trail is crossed at the northwest corner of section 33. The soil is six inches of loam over clay, with some stones in places. No coal or lignite veins were found. No stone quarries and no minerals of economic value were observed. The game was bear, rabbits, ducks and a few partridge.—*Hugh McGrandle, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 7—Continued.

58. This township is reached from Edmonton via Lac Ste. Anne, by a trail which enters the township at the southeast corner of section 5, and which is in very bad condition and almost impassable for wagons in wet weather. I cut a new trail around a number of swamps. Another trail via Belvedere post office crosses the north end of the township. This trail is also in bad condition, following hay sloughs, along creeks, and around small lakes. The soil in this township is mostly a clay loam over clay, but on the top of some of the ridges there is sand and gravel with some large stones; it is suitable for mixed farming. The surface is rolling to hilly, and is covered with a second growth of poplar and willow scrub, and is dotted over with small swamps of spruce and tamarack from six to ten inches in diameter. There is one or more of these swamps on almost every section. The southwest half of the township has no standing timber, except in the small swamps mentioned above, and a few small clumps of poplar on the south half of section 6. The northeast half of the township is dotted over with clumps of dead poplar and spruce. Along the east boundary is a considerable quantity of standing dead spruce from eight to ten inches in diameter. The greater part of section 1 is covered with green poplar from four to six inches in diameter, with some spruce from six to eight inches in diameter, and on the northeast quarter of section 31 is some large green spruce, poplar and cottonwood from ten to twenty-four inches in diameter. The whole surface of this township is covered with fallen timber, with the exception of patches where the timber has been nearly burned up. This is the case on portions of sections 7, 8, 17, 18, 20, 21 and 14. The standing timber, with the exception of that on the northwest quarter of section 31, is fit only for settlers' use. A creek from fifteen to twenty links wide, and from one to two feet deep, meanders through the centre of the township, from west to east. The north branch enters the northwest quarter of section 30, and the south branch enters the southwest quarter of section 18; the two branches join in the southeast quarter of section 30, and flow in an easterly direction through sections 29, 20, the southwest corner of 28, 21, 22, the southwest corner of 23, 14 and 13, leaving the township at the southeast quarter of section 13. The only hay seen in the township is on the southeast quarter of section 1, and along the valley of the above mentioned creek, where a considerable quantity of coarse slough hay could be put up. On the high land is a luxuriant growth of wild vetches which is excellent feed for stock until the snow falls. The water is slightly alkaline, but I think, sufficient and permanent. The above mentioned creek is supplied from springs, and there are several small ponds throughout the townships. There are no water-powers. The climate is fair; rather wet this summer, with light summer frosts, but not severe enough to harm early crops. Good potatoes were grown in the township this season. Wood for fuel is available on almost every section. There are no stone quarries. No minerals of economic value were found. Very little game of any kind was seen, except rabbits and ducks in season.—*Hugh McGrandle, D.L.S., 1906.*

59. *Part subdivision.*—This township is reached by the wagon trail from Edmonton, via McDonald's crossing on Pembina river. This trail crosses the north end of township 58, range 7, west of the fifth meridian, and is rough and in bad condition and almost impassable in wet weather, as it follows a chain of sloughs along creeks and small lakes. The soil is about six inches of sandy loam and stone over clay, suitable for grazing after the timber is removed. The surface is gently rolling and covered with heavy timber, consisting of spruce and cottonwood from ten to thirty inches in diameter, also some white birch. On the south half of section 31, and extending into 30, is an old brulé and windfall grown up with poplar and willow scrub. Sections 1, 2, 3 and 12 have been burned over lately, and there is now only small patches of green timber left on these sections. The township is watered by several small streams of good water, but the supply would not be sufficient and permanent in dry seasons.

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 7—Continued.

There are no water-powers. No minerals of economic value were seen. The game consists of moose, bear, rabbits and partridges. I would recommend this township for a timber berth, with the exception of the sections named above; in fact it was surveyed for a timber berth a year or so ago.—*Hugh McGrandle, D.L.S., 1906.*

Range 8.

58. *East outline.*—This township is reached by a wagon trail from Edmonton via Belvedere, entering the township near the northeast corner of section 25. This trail is rough and in bad condition, and would be almost impassable in wet weather. There is also an old pack trail (along which I took wagons) branching from the Lac Ste. Anne and McLeod river trail at Paddle river crossing and entering this township in section 13. The soil is a light clay loam from eight to twelve inches over clay, suitable for mixed farming. The surface is rolling and covered with small poplar and willow scrub, and a few small swamps of spruce and tamarack. The scrub and timber in this township is mostly all fire-killed, and another fire or two would convert a good portion of it into prairie, especially sections 12 and 13 and westward which is now called Peavine prairie. There is no timber of any value in the township except on section 36 which is covered with green spruce, poplar and cottonwood from ten to twenty-four inches in diameter. I saw no hay lands, but the surface is covered with a luxuriant growth of wild vetches. The northern portion is well watered by springs or small creeks of good water. There are no water-powers. For fuel there is a good supply of poplar and spruce in the northern portion of the township, and some small bluffs scattered over it. No stone quarries and no minerals of economic value were found. The game is bear, rabbit, sandhill crane and a few partridge.—*Hugh McGrandle, D.L.S., 1906.*

59. *East outline.*—This township is reached from the wagon trail crossing the north portion of township 58, range 7. The soil is a sandy loam over clay and stones, and is rated fourth class, with the exception of section 1 which is rated third class. The surface is rolling and covered with heavy timber consisting of spruce and cottonwood from ten to twenty-four inches in diameter, and poplar, balsam and birch from six to ten inches in diameter. There is no hay. Water is scarce. A few small creeks run through the township, but they are dry in a dry season. There are no water-powers. Wood is plentiful for fuel, but no coal or lignite was seen. No stone quarries and no minerals of economic value were seen. The game consists of moose, bear and rabbits.—*Hugh McGrandle, D.L.S., 1906.*

60. *East outline.*—This township is reached by pack trail along or near its outlines, from the wagon trail crossing the north end of township 58. An old pack trail crosses the east boundary of section 13, and appears to run parallel to Athabaska river which crosses the line at the northeast corner of section 25, and flows in a northeasterly direction through section 31, range 7. The soil is a sandy loam over stony clay, would rate fourth class, and is only valuable for its timber, or for grazing after the timber is removed. The surface is rolling, and very broken near the river, and is covered with heavy timber from ten to thirty inches in diameter, consisting of spruce, cottonwood and poplar. There is no hay. The township is well watered by small streams and ponds and Athabaska river. There are no water-powers. There is plenty of wood for fuel, but no coal or lignite was found. No stone quarries and no minerals of economic value were observed. The game consists of moose, bear, deer, rabbits and ducks, and fish in the small lake on section 1.—*Hugh McGrandle, D.L.S., 1906.*

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 11.

26. *Western part.*—A trail runs from Banff to lake Minnewanka traversing this area. This trail is always in good condition. The soil is rocky and gravelly, suitable only for grazing. The surface is covered for the most part with brulé and a thick growth of small jackpine. On sections 30 and 31 there is a considerable quantity of spruce as large as eighteen inches in diameter. This occurs in small bunches throughout both sections. There is no hay. The water is all fresh with a permanent and sufficient supply. Cascade creek will average in low water one-half chain wide, one foot deep and a velocity of six feet per second. There is no danger of floods. Water-powers could be developed on Cascade river, but it would require a long high dam with great danger of washouts. Summer frosts were observed every month during the summer. The climate is changeable but owing to the elevation very healthy. Both wood and coal are abundant in the township. Bankhead town and mine, belonging to the Pacific Coal company, are situated on section 19. Limestone boulders and ledges are found all over the district. None is quarried, however. Coal is the only mineral found. Mule deer, coyotes, mountain lion and bear are found in this township. No birds were seen, such as ducks or geese. The sections are underlaid with coal which is being mined by the Pacific Coal company. The coal mined is a rather inferior anthracite but gives very good satisfaction for domestic purposes. The coal company have extensive shafts, tipple, &c., and are especially well equipped with compressed air locomotives for speedy handling of cars, &c.—*C. C. Fairchild, D.L.S., 1906.*

27. *Sections 6 and 7.*—These sections are traversed by the Cascade river pack trail and are only accessible by pack or saddle-horse at present. There is little or no soil in the township. These sections are generally covered with spruce and jackpine averaging eight inches in diameter north of Cascade river and west of the Cascade trail, and with brulé and small jackpine on the balance of the township. There is no hay. There is an abundance of fresh water in Cascade river and numerous springs and creeks flowing into it. There is no suitable water-power owing to the shallow nature of the river and danger from anchor ice. Summer frosts are frequent. The climate is healthy. Coal and wood may both be procured on the sections. There are no stone quarries. Coal is the only mineral found. Deer and sheep were seen, also coyotes and mountain lions.—*C. C. Fairchild, D.L.S., 1906.*

Range 12.

26. *Part.*—This work lies contiguous to the Banff-Lake Minnewanka trail on the east side of Cascade mountain. To get into the sections on the west side of Cascade it is necessary to go in either over Stony Squaw mountain to Fortymile creek and thence along an old hunting trail up the valley between Cascade and Sawback mountains, or to go up the Cascade river trail to near the north boundary of township 27, range 12, and thence up a canyon between the two northerly peaks of Cascade mountain into the same valley between Cascade and Sawback mountains. I cut this trail out sufficiently to get through but expect fallen timber will soon fill it in again. This trail is on an average of one and a half miles from any of the lines surveyed in township 26, range 12, and these lines can only be reached on foot after a stiff climb. The portion of this township subdivided consists of the main part of Cascade mountain, and many of the section lines are wholly or in part inaccessible. There is little or no soil in the township, nearly all the surface being rock. The east side of the mountain, up to an elevation of 6,500 feet, is covered with spruce and jackpine averaging one foot in diameter, interspersed with brulé and thick small jackpine. There is no hay. There is plenty of good fresh water in the numerous springs and small creeks which run down the sides of the mountain, disappearing and reappearing at irregular intervals. There is no danger of floods except from snowslides. There are many miniature falls, some

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 12—Continued.

five or six hundred feet high, and the streams are all rapids and falls, but the volume is not sufficient for power purposes. The climate is healthy and bracing and frosts were observed every month, and when in high places on the mountains every day of summer. There is plenty of both coal and wood on the mountain. The Pacific Coal company's tunnel, I believe, runs under the mountain into this township. There are no stone quarries at present. Coal was the only mineral found. It outcrops along the small creeks in various places on the east face of the mountain, which has all been prospected. Mountain sheep are quite plentiful on Cascade mountain, and a few mule deer were seen, also two bear (grizzly), one mountain lion, numerous coyotes, but no mountain goat were observed. A few ptarmigan and rabbits were also seen.—*C. C. Fairchild, D.L.S., 1906.*

27. This township is reached by a pack trail known as the Cascade trail from Banff. This is a fair trail for a mountain trail. What little soil there is along Cascade river is suitable for grazing. The surface is generally timbered in the southeast part. The balance of the river valley is covered with burnt timber in a good state of preservation. The timber is all of spruce or jackpine and averages eighteen inches in diameter for the most part. There is no hay. There is plenty of fresh water obtainable in Cascade river and its numerous small branches. Cascade river averages one chain wide, two feet deep with a velocity of five feet per second. There is little danger of flooding. Considerable horsepower could be developed by the construction of dams, but anchor ice and liabilities of flooding due to snow slides, etc., would make the economic value of the water-powers doubtful. Frosts were observed every month, but the air is bracing and the climate healthy. There is plenty of both wood and coal in the township. The coal outcrops in fourteen different points on one stream in sections 1 and 12. These are exposed by prospecting work and seem a part of the same seams as are being mined at Bankhead. There are no stone quarries in the township. There are no minerals besides coal as far as I know in the township. Sheep, deer, bear, coyotes, mountain lion, porcupine, rabbits, marten, mink, partridge and ptarmigan were seen in this township.—*C. C. Fairchild, D.L.S., 1906.*

28. *Sections* 3, 4, 9, *and* 10.—These sections are reached by the Cascade river pack trail from Banff, which is a very good mountain trail. There is little soil in the township, that being clay loam and suitable only for grazing. The surface is generally covered with heavy brulé or dry standing spruce and pine averaging eighteen inches in diameter. This size is reduced as you ascend the mountains and entirely disappears on the tops. There is no hay. There is plenty of good fresh water in Cascade river and small tributary streams. The river averages one chain wide, one foot deep with a velocity of five feet per second. Water-power could not be economically developed owing to anchor ice. None of the land is liable to be flooded. The climate is good. Summer frosts were observed every month. Wood is plentiful on these sections. No coal veins were seen. There are no stone quarries. There are no economic minerals as far as I know. Bear, deer and sheep were seen in the township.—*C. C. Fairchild, D.L.S., 1906.*

Range 14.

76. The south third of this township is at present heavily timbered with poplar and spruce from four to sixteen inches in diameter, and the land is high and quite rolling. Where it adjoins Buffalo bay, an arm of Lesser Slave lake, it falls in terraces about a hundred feet to the beach near the shore. The Salt Prairie Settlement survey covers a large part of the prairie in this township, but outside of it there are sections 36, 35, 25, 26, 22, 23 and 24 and that part of the township north of the settlement sur-

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 14—Continued.

vey which have prairie spots and light timber and windfall easily cleared. The centre portion of the subdivision rises towards the south and east to the rolling heavily timbered land. There is a large spruce swamp on sections 18, 19 and 20, which the fire ran through this summer, uprooting and falling the timber in many places, and there are other smaller muskegs on sections 22, 23 and 26. The several branches of Salt creek become one in section 27, and it flows with a current of about two miles per hour and has a depth of from four to six inches and a width of twenty feet. It runs through a valley seventy-five feet deep and from five to fifteen chains wide to section 21, where it leaves the valley and is within its own banks, often overflowing them, until it reaches Buffalo bay near the southwest corner of section 18. There are three good wooden bridges over it, one in section 18, one in section 17 and another in section 21, all built by private means. The soil, which is black and sandy loam on clay with some sand and sandy loam, is generally good, and grass grows luxuriantly. There was only one squatter living in this township at the time of the survey, but improvements have been made on the northeast quarter of section 34, there being a house, a stable and five acres of breaking; also on the northwest quarter of section 17, on which a good log house is erected, besides a stable and some breaking. The meridian between sections 20 and 21 ran through the improvements made by the only squatter living on his claim, on which he had a house, stable and several acres of breaking. Where crops are growing this season they look so well I think it will not be long before there are numbers of settlers here, in fact before leaving the district several had taken up their residence. Timber, except on sections 13, 14, 15, 16 and 17 and the south third of the township, is of very little value except for fuel. Some good spruce and poplar for building purposes may be got on these sections. Water in Salt creek is good for general use, but I am told that where wells are sunk there is quite a strong mineral and in some cases saline taste. No rocks or stones were seen except a few rolling stones in some sections. The wagon road from Lesser Slave lake to Whitefish lake runs partly in the settlement survey and partly in the township, and since the survey was made I have driven over a road lately cut with the aid of government money north from the village through sections 5, 8, 16 and 21 and crossing Salt creek at the bridge on section 21. This road being on high land is intended to be used when the freshets flood the one usually travelled around the shores of Buffalo bay.—*Henry W. Selby, D.L.S., 1906.*

77. *South part.*—This township is composed of high rolling country of varying character, but the portion subdivided is nearly all good for farming purposes. The north one-third is at present not suitable for farming, the west portion being largely a spruce muskeg and the easterly portion very rolling with some sand hills covered with a growth of timber of little or no value. Sections 1, 2, 3, 4, 9, 10, 11, 12, 13, 14 and 23 are composed of good prairie land, the southeast part containing bluffs of small timber, poplar and willow. Good water can be had on nearly all of these sections. They are suitable for mixed farming and stock-raising. Grass grows quite luxuriantly and it is quite frequently made into hay by those living near by. The soil is four to twelve inches of black loam or clay. There are no settlers in this township, but some breaking has been done and a fence built on section 2 and section 3. Both of these are sure to make good farms. The remainder of the township is covered with poplar bush and scattered spruce with willow brush along the creeks and sloughs. Two branches of Salt creek pass through these lands, but there is very little saline taste to the water. The wagon road from Lesser Slave lake to Whitefish lake passes northerly through this township. It is my opinion that this township will be settled, it having the advantages of good soil, water, plenty of fuel, a good wagon road to enable settlers to reach the township, close proximity to the village of Lesser Slave Lake where hay and grain can be disposed of, while the danger from summer frosts will be no more than other parts

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 14—Continued.

of the country where the farming is successfully carried on. Moose and caribou tracks were observed but scarcely any other game.—*Henry W. Selby, D.L.S., 1906.*

Range 15.

75. East boundary.—This line was run on the ice because its course lay over so much water that it could not be done in the warm weather. Its north end is in Buffalo bay and in running south keeps a short distance west of the main outlet for nearly three miles, where the main land is again reached and a connection made with the survey of the Sucker Creek Indian reserve, No. 150*a*. The land along this line is not suitable for farming, but the township west is composed mainly of farming and meadow land. Thousands of tons of hay have been cut on these meadows and hundreds of horses range here every season.—*Henry W. Selby, D.L.S., 1906.*

76. This land may be conveniently divided, for the purposes of description, into the north and south halves. The north half, from a height of probably two hundred and fifty feet near the twentieth base line, lies with a general slope towards the south and southeast, where the south half, slightly higher than the waters of Buffalo bay, is met. Parts of sections 7, 18 and 13 being on the high land should not be included with the south half but as they lie mostly within the settlement survey, need not be affected by this division. All the sections north of the settlement survey although heavily wooded with poplar up to twelve inches in diameter, will make beautiful farms when cleared. And as settlement takes place and this wood is cut fires will make prairie land of it. Water was found only in the creeks running in coulées forty feet to fifty feet deep on sections 32, 33, 34 and 27 and this very strongly impregnated with alkaline or mineral taste, evidently fed by springs or underground currents. Springs were noticed on sections 18 and 19 in the settlement, the water of which though tasting of the mineral, was not so strong as in the creeks. Where wells have been sunk the water is quite strong for a while but improves on being used regularly. Wash creek, coming from section 32 and entering the marsh alongside of Heart river in section 22, has a rapid current. It does not average a depth of two inches and a width of two feet and apparently is fed by springs. It flows in a coulée fifty feet deep to the centre of the Indian reserve. Where the banks of the coulée end it has cut a channel and at high water several channels are running. I saw it in June near my camp on section 28 four feet deep and twelve to fifteen feet wide. This was the effect of only two days' rain, and it remained like that for three days before gradually subsiding. It can be imagined what would be the result upon South Heart river, which is only a little over a chain wide and seldom over two feet deep, with a current of about two miles per hour and which winds its way across the south half of this township. Several channels have been made through this low land the soil of which shows that it has been deposited by the ever recurring freshets and which had gradually risen until now the greater part of the low land remains dry at all times, but thousands of acres are still flooded by the sudden pouring of this volume of water into Buffalo bay. These old channels, or partly used channels are in places like rivers without any current, with bars in them where at low water one can cross dry-shod and at time of freshet with the current setting up stream carrying a canoe as fast as it will ordinarily downstream in the main channels. There are now at low water four mouths to South Heart river, and they are emptying such a quantity of silt or deposit into Buffalo bay annually that it remains only a question of time when this bay will become only the channel of South Heart river. In paddling a canoe over the bay at low water the bottom of the bay can be touched at from two to three feet and for a quarter of a mile from shore the water is not over six inches to a foot in depth. This low land at the mouth of South Heart river is very rich and grows great crops of hay besides

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 13—Continued.

pasturing hundreds of head of horses and cattle. There are dry elevations or low ridges and the banks of the old channels and other watercourses are thickly grown up with willow and towards the west side of the township several bluffs of poplar are found from two inches to ten inches in diameter, with some scattered spruce as large as fourteen inches in diameter. Peace River road leaves the road through the settlement at the east end of the Indian reserve (1500) and about a quarter of a mile westerly from this point the wagon road for Winakamu and Prairie Rivers settlement, branches southwesterly from Peace River road. Several of the lots have occupants, but there are none outside of the settlement survey at present. Many fields of oats, wheat and barley are seen which look very well though farming seems to be carried on in a half-hearted way yet, for the need of a better market. No rocks or quarries were discovered, and although there might be a good water-power on South Heart river by building a dam the opinion is given that it would be too great a risk to put one there on account of the sudden rise of the water at times. This township is essentially best suited for mixed farming and stock-raising. No game of any kind except a few partridge and rabbits were seen and one jumping deer south of South Heart river in the hay lands.—*Henry W. Selby, D.L.S., 1906.*

Range 16.

73. *East boundary.*—This line, with the exception of section 12 and part of section 13, passes through a thickly timbered country. Several spruce muskegs are crossed, but the north half of the township is covered with poplar and the land has a descent towards the north and is nearly dry. In the country lying along the 19th base line there is a large spruce muskeg very wet in places and a small quantity of large trees on the outer edge, but the average is quite small. East Prairie river crosses the line twice in the north half of section 12 and following a very crooked course passes out of the township in section 34. Land slides and the erosion of the banks by the water, have given the land adjoining the river an uneven appearance; one side frequently being only seven or eight feet high, while the other rises abruptly to a height of seventy-five or one hundred feet above the water. As seen from the west, north and east boundaries and from a walk south on the west side of the river, in sections 12 and 13 there are several prairie spots, the timber and brush having been burnt. My opinion would be that this township was not suitable for farming but would be more useful as a timber reserve.—*Henry W. Selby, D.L.S., 1906.*

74. A bird's-eye view of this township taken from any of the slight elevations around it, gives one the impression that it is covered with a dense growth of willow, large and heavy in places, which appears to conform to some regular but tortuous course while the smaller and less dense growth fills in the view. In fact the actual number of acres of prairie is very small compared with the whole. But the cleaning of the land with the willow upon it is a simple thing, and of the land not regularly flooded there should be very little that the average homesteader should object to on account of the brush. This township combines all the qualities for a settlement except a railroad to convey the produce capable of being grown therein to a market. People have been located there for some years, but they can use and dispose of only a limited quantity of grain, consequently many have not cultivated their land to any extent; but it is certainly suitable for grain growing or stock-raising. A little over four sections in the north end of the township may be called flooded land, but this will in the course of time become dry. From my observation the flooding of this place is caused by the stoppage of the water in the river by driftwood and log jams. I have seen a rise of six inches in the river above this land cause the water to flow over the sections from six to twelve inches deep for several days simply because the

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 16—Continued.

channel was so packed with logs and driftwood that it could not get through. Considerable dry timber for fuel can be got throughout the township, but once it begins to fill up with settlers they will be compelled to go south for their firewood. There is some timber in the south tier of sections but it is small and not standing very thick. Vegetation is generally very rank, stock looks well and a large quantity of hay is saved for winter feeding. The soil generally is a loose loam changing from black in the portion liable to flooding to a light loam or clay in those farther from the river. A good wagon road running from Lesser Slave lake to Sturgeon lake passes from east to west through this township and other roads branch off northerly for the use of settlers and to reach Slave lake without crossing so much water. East Prairie river follows a very crooked course with a general trend towards the north near the north end of the township, its channel is not much over half of the width it is in the south, but the current is more rapid. The greater part of the land is drained into East Prairie river through numerous coulées, some having small creeks in them at present, though most of them are dry. I am told that in some of these coulées at the time of high water in the river the water backs up several miles, and crops growing in fields adjoining them are benefited according to their proximity. No rocks or quarries were noticed, or game of any kind.—*Henry W. Selby, D.L.S., 1906.*

75. *Southwest six sections.*—For the present it was thought unnecessary to cut the lines through the balance of this township as much of it is flooded by East Prairie river. These six sections are nearly flat and are composed of prairie with large bunches of willow brush and willow fringed coulées. A quantity of black poplar and spruce is found on the north half of section 4. A sawmill is in operation about a half mile east of the east boundary of section 4 which has been supplied with spruce logs from the land adjacent to the river and its tributaries. This timber is of a good size, but is scattered. Two squatters have made improvements on section 6, but the amount of breaking is small all through this settlement, since the market is very limited. Much progress cannot be looked for without a railway.—*Henry W. Selby, D.L.S., 1906.*

7. The northern two-thirds of this township, with the exception of small portions south of the wagon road to Lesser Slave lake, is well suited for mixed farming and stock-raising. The soil is black loam on clay subsoil, and grass and vetches grow luxuriantly all over it except on the most heavily wooded sections, though not to the same extent that it does in parts of Prairie River settlement. There are two small creeks, one of which rises a short distance north of the base line in the high lands and flows in a coulée about twenty-five feet deep through section 32, where the coulée ends. The other rises in section 36 and flows through sections 35 and 27 in a coulée about twenty feet deep. From these points the coulées become simply rolling country and the creeks find their way to the low lands near Heart river. Many grassy sloughs which are nearly dry this year are found in sections 20, 21, 28 and 29. The settlement survey covers nearly all the prairie sections, but prairie is found sufficient for a good start on sections 16, 17, 18, 20, 21, 22, 27 and 28. On these the land is good, being clay, and black loam on clay subsoil, while the timber is small and not difficult to clear. Bluffs of poplar suitable for building purposes and fuel are on each of these. On the north half of section 17 a piece of breaking of about two acres is fenced, but no buildings have been built and there is no crop in yet. There is a house partially built in the southwest quarter of section 23, but no one resides there. In fact no one lives in this township except one settler on lot 110, one on 108 and one on lot 104, though there are crops growing on several of the settlement lots which the frosts of several cold nights do not appear to have injured. The chord four miles south of the base line runs through the low lands adjacent to Heart river, locally called Horse

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 16—Continued.

lakes when flooded. These basins or lakes were dry last year. In May of this year there was no water to be seen in them. In June the greater part of sections 8, 9, 10, 11 and 14 were covered to a depth of two to four feet of water after a rain of two days duration. In September very little water is to be seen in them. The reason for this flooding appears to be that East and West Prairie rivers flow into South Heart river in township 75, range 16. The quantity of water usually flowing in each of the Prairie rivers is about equal to that flowing in Heart river and the banks of Heart river being only about seven feet high cannot receive this extra flow of water. Consequently it has to overflow, some to the north of Heart river and some into basins south and along the Prairie rivers. This land not being at present suitable for farming or grazing I did not subdivide it. The heaviest timbered sections are 19, 30, 31, 32, 33, 34, 35 and 36; on these the timber is mainly poplar from two inches to twelve inches in diameter, with some willow. On the rest of the township the poplar is small and scattered and mixed with willow. A few trees of spruce and tamarack up to fourteen inches in diameter are seen on the south boundary of section18 and along the west halves of sections 6 and 7, there are some good spruce and tamarack but only a small quantity and probably more useful for the needs of the settlers than for commercial purposes. No game was seen in this township but among the berry bushes tracks of bear were observed.—*Henry W. Selby, D.L.S., 1906.*

Range 17.

74. Before deciding as to the subdivision of township 74, range 17, after running the east and south outlines, I travelled over a large part of it and for the following reasons decided to subdivide only the east two miles for the present. The main reason being that there is more timber and brush west of Prairie river, than homesteaders care to locate on, until settlers become more numerous. And although in sections 18 to 14 and 19 to 23 there are numerous prairie spots and the grass and vegetation is quite rank and the soil all that could be desired, there are wet sloughs, coulées and some muskegs which make it look uninviting. The southerly third of the township west of the river falls gently towards the north and west, has poplar and willow all over it, and the soil is mostly a white clay with very little loam. The northerly third is more or less heavily timbered and flooded by the high water of West Prairie river, but as this does not often occur, this land may be suitable for stock-raising, but for the ordinary ranch where cattle and horses are supposed to rustle all winter, I do not think this part of the country will be suitable without providing hay for three months when the snow gets a crust on it. Sections 1 to 12 and the west parts of 26 and 35 are covered with poplar and willow and there is considerable willow and a few poplar bluffs scattered over the remainder of this part of the township, but there is not a quarter section of this latter part that has not enough prairie on it to give a settler a good start, as is evidenced by the number of claims already occupied. The peculiar feaure of this part of the country is the large number of coulées or watercourses fringed with willow and scattered poplar, which now are nearly dry, but some have old beaver dams across them which hold the water back in ponds. These coulées or ravines appear to have been washed out by the water in the spring, made by the melting snow over an almost level surface, and they run in every direction, many flowing at right angles to others and begining near others already formed. Some again, show their origin from springs or underground currents, since there is a small stream flowing at all times of the year and the banks of the coulées are constantly sliding in. This would not occur if it were only a watercourse. The vegetation on sections 2, 11, 14, 23, 25 and 36 is decidedly more rank than on the other sections, but from the information to be had it does not appear to be an advantage for where I have seen crops growing and the grass and weeds are not nearly so rank the yield of grain was greater.

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 17—Continued.

The soil where the vegetation grows rank seems more loose and spongy, while in the other case it is closer and more difficult to cultivate. This rank vegetation had to be cut down to get the lines through. Mr. F. Mearon, who has been on the southeast quarter of section 24 for the past three years, has thirty-five acres of land broken and under crop this season. It is well fenced and he has good log buildings, machinery necessary to work his farm with, ten head of horses and four head of cattle. He came there practically without anything, showing what industry and thrift ought to do on such soil. His crop this year is very good, some being so heavy as to lodge. Frost has not injured any of the crops in this township, the potatoes being green in the end of September. Vegetables of all kinds appear to do well and grow to an amazing size and quality. There are plenty of bear along West Prairie river and jumping deer were seen in the township and coyotes are very numerous.—*Henry W. Selby, D.L.S., 1906.*

75. In running the east outline of township 76, range 17, I found the sand hills and spruce muskeg to continue southwesterly to so great an extent and South Heart river and West Prairie river cutting in, several parts and places along these rivers subject to flooding and the land at present unfit for settlement, that I decided not to subdivide it. But when the east outline was run three settlers were found within the first mile west, with valuable improvements and farms of the best quality of soil. Consequently the survey of sections 1, 12, 13 and 24 was completed. The only portions of section 1 not suitable to farm are the two coulées which drain it, and through which spring creeks are running most of the year, furnishing water for the stock owned by the two settlers on the section. The coulées are therefore a benefit instead of otherwise. The crop of oats, wheat and barley grown by Joseph Ferguson on the northeast quarter of section 1 is excellent and when the land is properly worked will greatly improve as the soil is a rich loam on clay subsoil. Grass grows very rank and with it thick masses of vetch and peavine. The settlers can go almost anywhere on the prairie and put up from three to five loads per acre, while stock destroys more than they eat. The water found in the coulées has in most cases an iron or alkaline taste but the well water after being used for a while becomes free from this mineral taste. Many frosty nights have occurred this season, but little or no damage has been done and that little only in case of grain sown late. Garden produce such as potatoes, cabbage, beets, turnips, carrots and lettuce have developed to a perfect state. One has only to observe the condition of the horses, cattle, pigs, &c., to arrive at an opinion as to the rich quality of the soil and its produce. Sections 12 and 13 are equally good as section 1 except that more willow brush is found growing along and between the various watercourses, but the quality of the soil and vegetation would indicate their fitness for farming purposes. A very imperfectly farmed field of oats put in by A. McDonald on these sections has been cut and although not threshed the turnout promises exceedingly well. Section 24 is somewhat cut up by South Heart river and the land adjacent to it is more or less flooded and cut into by the water when the floods subside, but the east half has very little land on it that cannot be farmed and the west half will do for grazing or hay when the brush and timber is cut. The first road into the settlement from the north was opened through this section, being free from danger of flooding from the rise of the water in the rivers.—*Henry W. Selby, D.L.S., 1906.*

Range 19.

64. *North outline.*—In section 34 the line intersects, seven times, Atikkamek ('poisson blanc') creek, a tributary to Atimsegun ('dog's tail') river. This river, after crossing the line near the northeast corner of section 31, flows northwest into

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 19—Continued.

Little Smoky river. The country is flat and swampy in many places. The high land is wooded with spruce six to twenty-four inches in diameter, poplar six to fifteen inches and jackpine five to ten inches, also birch, balsam and fir, while in the swamps there is tamarack six to twenty inches in diameter. The soil is black loam four to eight inches deep with a clay subsoil. The Lake St. Ann pack trail (southern one) to Sturgeon lake passes close to the northeast corner of section 33.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 20.

64. *North outline.*—This township has a gently rolling and wooded surface ; there are some tamarack swamps with timber eight to fifteen inches in diameter. The divide between Atimsegun and Little Smoky rivers is in section 31 (altitude 2,350 feet above sea level). Through section 34, flows a creek which empties into lake Giroux whose eastern extremity lies three-quarters of a mile north of the line. This lake is about three miles long by one mile and a half wide, and lies in a northwesterly direction. North of it the land is high and supports a good growth of poplar and spruce, but to the west it appears to be low and swampy. The soil is black loam, four to six inches deep with a clay subsoil. An old pack trail leading north crosses the line in section 35.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 21.

64. (*North outline*).—This township is heavily timbered with spruce ten to thirty inches, jackpine six to twelve inches, and poplar, balsam, fir, birch and tamarack six to ten inches in diameter. Its surface is undulating except in section 33, where steep hills lead down to Little Smoky river (2,050 feet above sea level). This stream, which flows from the southeast, crosses the north boundary of this section three times. It is three chains and a half wide, has a swift current running over a stony bottom, and has high cut banks. It is not navigable. Its valley, which is two hundred feet deep, is about one mile wide between the crests of the hills which bound it on each side. The pack trail (southern one) between Lake St. Ann and Sturgeon lake, passes through section 35, east of Little Smoky river. The soil is a black loam with a clay subsoil; it changes to a sandy loam over a mixture of sand and clay in the valley of Little Smoky river. A few stones were seen on the surface in places. The land west of the river is high, rolling and covered with bad windfall. It is wooded with spruce from ten to thirty inches in diameter, balsam, fir and cottonwood with heavy undergrowth of alders. The soil is a black loam two to six inches deep, over a subsoil of clay mixed with stones or coarse gravel. The general slope of the country is towards the northwest.—*Arthur Saint Cyr, D.L.S., 1906*

80. *North outline.*—The surface is undulating and is well wooded. A hay marsh half a mile long lies one-quarter of a mile south of the base line in section 31. Small streams, tributaries to North Heart river, cross the line in sections 34 and 35. In sections 31 and 32 the subsoil is clay mixed with gravel and stones. In the rest of the range the soil is blue clay covered by a few inches of loam. Throughout this township there are many willow swamps. An Indian pack trail from 'Little Prairie' crosses the line in section 34. Smoky river and the country east of it is now accessible by a wide road which I had to cut in order to reach the initial point of my survey.—*Arthur Saint Cyr, D.L.S., 1906.*

84. Peace river flows from south to north across this township and crosses its north boundary in the middle of section 33. The river is here half a mile wide. From the river the land rises gradually till at one and a half and three-quarters of

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 21—Continued.

a mile from the right and left banks respectively it reaches an altitude of 700 feet. Across the line and close to the right bank lies an island wooded with cottonwood and spruce. East of the river the country is covered with young poplar, willows and alders and broken by deep ravines. Solid timber begins half a mile south of the line and extends southerly to Peace River Landing. The soil is light in the vicinity of the river.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—Peace river flows from south to north across this township and crosses the north boundary in the middle of section 33. The river is here half a mile wide. From the river the land rises gradually till, at three-quarters of a mile from the left bank, it reaches an altitude of seven hundred feet. Across the line, and close to the right bank, lies an island wooded with cottonwood and spruce. East of the river the country is broken by deep ravines and is covered with young poplar and willow and alder scrub. Solid timber begins half a mile south of the line, and extends southerly to Peace River Landing. The soil is light in the vicinity of the river. Where the line intersects the right bank of Peace river I noticed an outcrop of sand stone fifty feet in height. This outcrop extends for a considerable distance on either side of the line. Lying close to the right bank of the river there are also, in this vicinity, many islands, all wooded with cottonwood and black poplar. The middle of township 68, range 21, includes the valley of Peace river, which flows through this township from south to north. This township is consequently much cut by deep and wide gulches, separated by some narrow bench land. The soil in one-half of section 33 and the whole of section 34 is poor. In the other two sections it is a black loam four to eight inches deep, with a clay subsoil. The land is covered with small poplar and willow scrub.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 22.

80. *North outline.*—The height of land between the Smoky and North Heart rivers occurs in section 34. West of this divide, in sections 31, 32 and 33, are many large hay marshes, while east of it the ground slopes gently towards the valley of North Heart river. The land in this range also is wooded with poplar six to ten inches in diameter. There are many willow swamps. The soil is the same as in range 23. —*Arthur Saint Cyr, D.L.S., 1906.*—

84. The country is rolling, covered by bad windfall. A pack-trail leading to the Roman Catholic mission crosses the line in the middle of section 34. There is a large hay marsh in section 33 and an extensive muskeg in section 32. The soil is a black loam 2 to 8 inches deep overlying a clay or gravelly clay subsoil.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—The surface is rolling, and is covered by heavy windfall. A pack-trail leading to the Roman Catholic mission crosses the line in the middle of section 34. There is a large hay marsh in section 33, and an extensive muskeg in section 32. The soil is a black loam from two to eight inches deep with a clay or gravelly subsoil.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 23.

80. *North outline.*—Smoky river flows northerly through the middle of this township, and crosses the north boundary a short distance west of the northeast corner of section 33. At this point the river is three hundred and thirty yards wide, and has a swift current flowing over a stony bottom. Precipitous hills rise to a height of seven hundred feet on both sides of this stream whose valley is one mile and a quarter wide.

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 23—Continued.

With the exception of the immediate vicinity of the river, where the land is much broken by deep ravines, high mud banks and land slides, the country is either level or undulating and supports a thick growth of poplar, spruce, birch and cottonwood with heavy undergrowth. The soil is a few inches of loam over a clay subsoil.—*Arthur Saint Cyr, D.L.S., 1906.*

84. The outlet of Bear lake flows northerly through section 32. The land is swampy for some distance on each side of this stream which is a tributary of Whitemud river. Another stream flowing southeast is crossed in section 36. On the swampy land found in this vicinity a limited quantity of hay could be cut. A wagon road leading to Chas. St. Germain, a settler living at the Peace river, has been cut along this creek as far as the base line. The last mentioned creek is reported to head from two small lakes lying four miles north of the line.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—The outlet of Bear lake, which is a tributary of Whitemud river, flows northerly through section 32. The land is swampy for some distance on each side of this stream. Another stream, flowing southeast, is crossed in section 36. On the swampy land, found in the vicinity, a limited quantity of hay could be cut. A wagon road, leading to the place of Chas. St. Germain, a settler living near Peace river, has been cut along this creek as far as the base line. This last mentioned creek is reported to have its source in two small lakes lying four miles north of the line.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 24.

80. *North outline.*—The surface is undulating and is wooded with poplar, birch, cottonwood and some spruce from five to fifteen inches in diameter. The soil is a black loam, two to five inches deep over a clay subsoil. There are many small willow swamps and a large muskeg extends north of section 33. A small creek flowing northerly, intersects the north boundary of section 32.—*Arthur Saint Cyr, D.L.S., 1906.*

84. The surface of this township is undulating, stony and swampy in places and covered with windfall. The soil is a black loam 2 to 6 inches deep; the subsoil is clay. All the timber has been destroyed by fire. A creek coming from the northwest crosses the base line near the corner of section 32. Through the middle of section 36 runs an Indian trail, leading to Bear lake. The eastern extremity of Whitemud hill is in section 35.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—The surface of this township is undulating, is swampy in places, and is covered with windfall. The soil is a black loam two to six inches deep, with a subsoil of clay and is, in places, stony. All the timber has been destroyed by fire. A creek, coming from the northwest, crosses the base line near the northeast corner of section 32. Through the middle of section 36, runs an Indian trail, leading to Bear lake. The eastern extremity of Whitemud hills is in section 35.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 25.

84. The north boundary of this township runs over the south slopes of the Whitemud hills, where all the timber was a few years ago destroyed by fire. The land which is stony in places is high rolling and supports a second growth of poplar with willows and alders. The soil consists of a few inches of loam overlying a subsoil of clay. A large creek running south crosses the base line at the corner of section 32 and flows into the west end of Bear lake. A well defined pack trail follows along the east bank of the stream and leads to the south shore of Bear lake, where it joins the

TOWNSHIPS WEST OF THE FIFTH MERIDIAN.

Range 25—Continued.

wagon road to Brick's settlement, on Peace river. Other small streams also cross the line in every section, all flowing into Bear lake.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—The north boundary of this township runs over the south slope of the Whitemud hills, where all the timber was a few years ago destroyed by fire. The surface is high rolling and the land which is stony in places is covered with willow and alder scrub and second growth poplar. The soil consists of a few inches of loam over a clay subsoil. A large creek running south crosses the base line at the northeast corner of section 32, and flows into the west end of Bear lake. A well defined pack trail follows along the east bank of this stream, and leads to the south shore of Bear lake, where it joins the wagon road to Brick's settlement on Peace river. Other small streams also cross the line in every section, all flowing into Bear lake.—*Arthur Saint Cyr, D.L.S., 1906.*

Range 26.

84. This is a fractional township adjoining the sixth meridian which intersects its north boundary at 65·19 chains west of the corner of section 35. The country in the vicinity is gently rolling and covered with a second growth of poplar with willows and alders. Considerable dead timber is lying on the ground; green timber of small diameter is found only in clumps scattered here and there. The soil is a black loam 2 to 10 inches deep; the subsoil is clay. A creek flowing to the south crosses the line in section 35. Stones were noticed on the surface.—*Arthur Saint Cyr, D.L.S., 1906.*

84. *North outline.*—This is a fractional township. The sixth meridian intersects its north boundary 65·19 chains west of the northeast corner of section 35. The country in this vicinity is gently rolling and is covered with windfall, willow and alder scrub and second growth poplar. Green timber, of small diameter, is found only in clumps scattered here and there. The soil is a black loam two to ten inches deep with a subsoil of clay. A creek flowing to the south crosses the line in section 35. Stones were noticed on the surface in places.—*Arthur Saint Cyr, D.L.S., 1906.*

TOWNSHIPS WEST OF THE SIXTH MERIDIAN.

Range 24.

18. I ran a part of the north boundary of section 31 and the west boundaries of sections 31 and 30 and traversed the right bank of Thompson river through these sections. The land surveyed in this township is open, hilly, rocky and broken and only fitted for grazing purposes. I was told that there are some gypsum deposits of some value here. Some tunnelling and development work had been done on the southeast quarter of section 36 and the northeast quarter of section 25, township 18, range 25, west of the sixth meridian. I did not make any examination of the work done. The surface indications point to the bulk of the mineral as lying in the two last mentioned quarter sections.—*Jos. E. Ross, D.L.S., 1906.*

20. I ran the north boundary of section 8 and the part of north boundary of section 7 lying east of Thompson river. The part surveyed is open and hilly. There is some bench land which could be cultivated. It would need to be irrigated. I understand that the Canadian Pacific Railway company object to the land here being irrigated, as it causes the high banks along the railway to slide out.—*Jos. E. Ross, D.L.S., 1906.*

SPECIAL REPORT

OF THE

COMMISSIONER OF THE YUKON TERRITORY

FOR THE YEAR ENDING MARCH 31

1908

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1908

[No. 25*c*—1908.]

COMMISSIONER'S OFFICE,
YUKON TERRITORY, CANADA,
DAWSON, April 15, 1908.

Hon. FRANK OLIVER,
Minister of the Interior,
Ottawa.

SIR,—I have the honour to submit the report of the Yukon Territory for the fiscal year ending March 31, 1908.

GOLD PRODUCTION.

The gold production in the Territory, as taken from the returns in the comptroller's office for the year ending March 31, 1908, was 189,011·68 ounces, which, at $15 per ounce—which is the valuation for royalty purposes—would amount to $2,820.161.60. This is the lowest output in the history of the territory, since 1898, and is due mainly to the fact that a considerable number of the claims on Hunker, Bonanza and Eldorado creeks were not worked during the year, having been acquired by the Yukon Gold Company for dredging and hydraulicking purposes.

DREDGING.

The Yukon Gold Company has installed three large dredges on Lower Bonanza, one on No. 90 below and two on No. 104-A below Discovery; which were worked during the greater part of the season of 1907, but owing to encountering frozen ground the work was not as extensive as was anticipated in the early part of the season. Another dredge has been constructed on No. 90 below Discovery on Bonanza creek, and will be operated as soon as the season opens. This company is also constructing three dredges on Hunker creek, which it is expected will be working this season.

In connection with the construction of ditches and flumes by this company, 17 miles of ditching have been completed and about 4 miles of flume; the remainder of the flume is ready to be put in as soon as the weather permits, the foundations being already prepared. There is also 12½ miles of piping on the ground ready to be put together. The syphon, which will be used to convey the water across the Klondike valley, is all in position to be assembled, and has a capacity of 5,000 inches, being 49 inches inside diameter and 15,760 feet long.

The hydraulic electric transmission plant on the Twelvemile river is completed, and power will be supplied to all the gold-bearing creeks within the Dawson mining district for the company's several works, such as dredges, electric lifts, &c. Three electric lifts have been constructed by this company on Bonanza creek, and will be used this summer. The dam, which has been under construction at No. 57 above Discovery on Bonanza creek, is now completed, and will store 350,000,000 gallons of water; this water is to be used for hydraulicking the bench gravels on Bonanza creek, enabling the ground to be worked during the dry season, usually the months of June, July and August. There are two ditches, each 1.000 inches capacity, conducting the water from this dam down Bonanza creek, which will supply two large hydraulic plants; it will also be used in connection with the electric lifts in the creek bottoms.

This company expects to have all its works completed and to be in a position to undertake active operations during the season of 1909.

The Canadian Klondike Mining Company is still operating in the Klondike River valley at a point near the mouth of Bear creek. This dredge has an average capacity of 2,800 cubic yards per day of 24 hours, and during the season of 1907 was in operation for 167 days.

The dredge belonging to the Bonanza Basin Gold Dredging Company was entirely remodelled last year, the motive power having been changed from steam to electric power.

The Lewes River Dredging Company operated on Discovery claim on Bonanza creek, but has since been removed to No. 6 below Discovery, and will continue there during the present season.

The dredge which has been operated in the submerged bed of the Klondike river has been removed to Indian river, and is being operated there by the Indian River Gold Mining and Development Company, Limited.

The Fortymile Dredging Company operated a dredge last season in the submerged bed of that river, and material to remodel this dredge is now being freighted there. Another dredge has been ordered by this company from San Francisco, and is expected to be delivered during the summer of 1908.

The submerged leaseholds owned by Wm. Ogilvie and others on the Stewart river have not been worked for several seasons, but a new company has been formed, viz.: The Yukon Basin Gold Dredging Company, capitalized at $20,000,000. A dredge is now being constructed at Whitehorse and will be taken down the Yukon river to these leaseholds as soon as completed. The company contemplate constructing during the present season, another dredge to operate on the Stewart river.

INDIVIDUAL MINING.

Individual mining operations have been carried on at Granville on Lower Dominion, and on Sulphur, Quartz and Eureka creeks, with, it is understood, good results. New discoveries were made on Blackhills creek, and on Little Blanche, a tributary of Quartz. Blackhills is a tributary of the Stewart river, and is situate in the Dawson mining district. Two hundred and fifty-two creek and 100 hillside claims have been staked ,and about fifty claims on its tributaries. There are about fifty individual plants operating on this creek, and the prospects for a good clean-up in the spring are excellent.

Quite a considerable amount of work was done in placer mining in the Salmon River district, principally on Livingstone creek. There are about 125 men working in that district.

There has been increased activity in the southern end of the Territory in copper and quartz. Last season's development work has disclosed greater ore bodies than even the most sanguine operators anticipated. The White Pass Railway Company contemplates building a spur line to some properties near Whitehorse, and have also erected ore bunkers at Skagway to facilitate the handling of ore.

YUKON COUNCIL.

The Yukon Council met on August 8, 1907, and prorogued on August 30, 1907. Fourteen ordinances were passed in connection with the local administration, and other necessary business transacted. A committee on mining was appointed by the Council and instructed to make such representations as to amendments to the Yukon Placer Mining Act and the Quartz Regulations as were deemed advisable. These recommendations have been forwarded to you, and it is satisfactory to note that a Bill embodying many of the proposed amendments has been presented to parliament. One of the most important amendments to the local ordinance was the repeal of the section licensing music halls. The passing of this amendment has led to the abolition of dance-halls in the Territory.

The revenue of the Territory for the nine months ending March 31 was $332,846.72, and the expenditure $338,755.10.

SCHOOLS.

The schools have been maintained during the past year in a very high state of efficiency, and the results obtained have given the highest satisfaction to the people of the Territory.

ADMINISTRATION OF JUSTICE.

The Territory during the past year has been remarkably free from crime of a serious nature. This condition I have no doubt is due to a large extent to the law-abiding spirit pervading the people of this Territory, but I do not wish to detract in this regard from the great credit due to the highly satisfactory administration of justice and the activity and devotion to duty of the Royal Northwest Mounted Police under the able supervision of the Assistant Commissioner, Major Wood.

GENERAL.

The people of this Territory have been hopefully looking forward to the probability of railway connection with the other parts of this Dominion, and any proposal to secure connection either by an extension of the Klondike Mines Railway, which extension is now contemplated, or some other satisfactory connection, would be eagerly welcomed. It is confidently believed that such railway connection would open up vast areas of agricultural, coal and mineral lands and afford opportunities to a large population.

The same spirit of optimism which has hitherto prevailed, still exists among the people of this Territory.

I have to bear testimony to the efficient service rendered by all the officials of the different departments of government in the Territory.

Reports from the Comptroller, Gold Commissioner, Crown Timber and Land Agent, Director of Surveys, Government Mining Engineer, are herewith enclosed.

I have the honour to be, sir,
Your obedient servant,

ALEXANDER HENDERSON,
Commissioner.

Department of the Interior, Canada,
Comptroller's Office,
Dawson, Y.T., April 10, 1908.

Hon. Alexander Henderson,
Commissioner of Yukon Territory,
Dawson.

Sir,—I have the honour to submit my annual report for the year ending March 31, 1908.

The expenditure under the vote 'Administration of the Yukon,' through the Department of the Interior disbursed through my office was $145,912.56; statements with vouchers being forwarded to the department at the end of each month.

The expenditure on account of Department of the Interior 'subsidy to river steamers,' being amounts paid to steamers for making trips on rivers not usually travelled, to assist prospectors and miners in getting in their supplies, amounted to $6,061.75.

The local revenues and expenditures of the Yukon Territory from July 1, the beginning of its fiscal year, to March 31, 1908, were: revenue, $332,846.72; expenditure, $338,755.10, administered through my office; quarterly statements with vouchers being sent to the Auditor General as required by order in council. I attach a copy of the balance sheet on March 31, 1908.

The disbursement on account of the Department of Justice was $25,822.60, for services in connection with this Territory; monthly statements being forwarded, with vouchers.

The expenditure on account of the Department of Indian Affairs for the relief of sick and destitute Indians, &c., was $7,400.19.

The expenditure on account of the Department of Public Works 'buildings,' has been managed through the Superintendent of Public Works and the Comptroller; the expenditure was $69,935.33.

The expenditure on account of the Department of Public Works 'river improvements vote,' amounted to $6,768.09.

The royalty collected in the Territory amounted to $70,511.20: collected at Dawson, $69,011.30; Whitehorse, $1,495.10, and Fortymile, 75 cents.

The receipts from free certificates issued to exporters of gold from Alaska were $156.50.

Revenue from both these sources was forwarded to the credit of the Receiver General, drafts being sent to the department weekly and statements at the end of each month.

The revenue from the sale of Yukon Territorial Court law stamps was $3,750.95; from Mining Court stamps to January 31, 1908, $272.25; drafts and statements being sent to the Department of Inland Revenue. As the Gold Commissioner's Court was abolished, the Mining Court stamps on hand were returned to the Department of Inland Revenue on February 24, 1908.

Monthly statements of the revenue received in the office of the Gold Commissioner and Crown Timber and Land Agent have been checked each month as formerly, and the returns forwarded to the department. The suspense account in the Gold Commissioner's office has been checked and the cheques countersigned in payment of the vouchers.

As the management of the City of Dawson was transferred to the government of the Yukon Territory, the revenue and expenditure on that account have been put through the local revenues of the Yukon Territory instead of being kept separately as formerly, and vouchers for the City of Dawson have been sent to the Auditor General's Department in the same way as the other services of the Yukon Territory.

In the balance sheet inclosed, there are two groups: group one representing the revenue and expenditure of the Yukon Territory, and group two representing the revenue and expenditure of the City of Dawson.

I have the honour to be, sir,

Your obedient servant,

G. I. McLEAN,

Acting Comptroller.

TRIAL BALANCE, GOVERNMENT YUKON TERRITORY, MARCH 31, 1908.

Appropriation.		Dr.	Expenditure.	
4,000 00	Group One.	Indemnity and travelling expenses Yukon Council	3,660 00	
8,050 00		Town of Whitehorse	7,365 98	
23,900 00		Salaries and travelling expenses	17,176 60	
1,750 00		Preventive Service	946 60	
5,000 00		Printing and Stationery	3,781 86	
900 00		Whitehorse Library	600 00	
56,515 00		Schools	36,283 45	
34,000 00		Hospitals, Charities and Quarantine	23,722 97	
5,000 00		Contingencies	2,603 38	
4,300 00		Dawson Free Library (Terrtiory)	3,325 00	
143,785 00		Roads, Bridges and Public Works	152,146 66	
7,000 00		Miscellaneous Expenditure	5,127 01	
1,800 00		Law Library	1,184 45	
10,000 00		Bonus to Mining and Maintenance Assay Office	5,997 36	
....	Group Two.	Indebtedness of City of Dawson	20,954 80	
50,126 00		Dawson Fire Department	35,314 80	
10,000 00		Maintenance Streets and Sidewalks	8,527 17	
2,500 00		Street Lighting	2,542 50	
1,000 00		Printing and Stationery (City)	374 86	
2,000 00		Maintenance of Dog Pound	1,351 50	
1,500 00		Contingencies (City)	653 20	
2,100 00		Dawson Free Library (City)	1,575 00	
4,760 00		Salaries (City)	3,539 95	
		Balance on hand	7,777 32	
				346,532 42
Estimated Revenue.		**Cr.**	**Revenue Received.**	
	Group One.	Balance from 1906-07	13,685 70	
45,000 00		Liquor Licenses (Less 24,000 City)	44,938 58	
45,000 00		Liquor Permits	48,155 37	
100,000 00		Dom. Govt. Grant (Roads, Bridges, etc)	75,000 00	
125,000 00		Dom. Govt. Grant (Local purposes)	93,750 00	
15,000 00		Local taxation (Terry)	16,624 70	
24,000 00	Group Two.	Proportion Liquor Licenses (City)	....	
50,000 00		Taxation (City)	53,048 57	
5,000 00		City Licenses and Sundry Revenue	1,329 50	
				346,532 42

OFFICE OF THE GOLD COMMISSIONER OF THE YUKON TERRITORY,
DAWSON, Y.T., April 13, 1908.

Hon. ALEXANDER HENDERSON,
Commissioner of the Yukon Territory,
Dawson, Y.T.

SIR,—I have the honour to submit herewith the annual report of the Gold Commissioner's office for the fiscal year ending March 31, 1908.

The financial statement hereto attached, in addition to showing the receipts from the different branches of the office, gives a statement comparing the receipts of the fiscal year in question with the previous year.

The total receipts amount to $121,246 (one hundred and twenty-one thousand two hundred and forty-six dollars).

As you will notice by the comparative statement, this is an increase of revenue over the previous fiscal year of $16,197.70 (sixteen thousand one hundred and ninety-seven dollars and seventy cents). In making the comparison it must be remembered that the previous fiscal year was only nine months in legth of time; however, I find that the revenue for the present year in question is $682.74 (six hundred and eighty-two dollars and seventy-four cents) more than the fiscal year ending June 30, 1906.

It will be noted in the comparative statement that there is a large decrease of revenue this year in the issue of free miners' certificates, owing to the fact that free miners' certificates were done away with when the Placer Mining Act came into force.

In the face of this source of revenue being cut off, the total revenue for the year should be considered satisfactory.

Hereto attached will be found a statement compiled by the Mining Recorder, giving the number of locations and relocations on each creek in the Dawson district, showing what portion of each are creek, hill, bench, river or bar claims. During the year 1,397 new locations were recorded and 587 relocations of claims that had expired.

Hereto attached will also be found a statement compiled by the Mining Engineer, in which will be found a list of creeks upon which active mining operations are being carried on; the number of claims on each creek in which mining operations are being carried on; a general statement as to the mining operations in the Territory; as to new discoveries; as to the influence of new mining methods; as to coal and as to wood. These statements are carefully compiled and are accurate.

Individual mining operations by what is known as the ordinary mining methods are now confined almost altogether to lower Dominion creek, in the vicinity of Granville, and to Quartz creek, and as time goes on will diminish, as the pay gravel that can be worked profitably in this way is coming to an end.

I am of the opinion that in the near future mining operations will be confined practically altogether to hydraulicing and dredging.

When the Yukon Gold Company have completed their ditch from Twelvemile and when this company, with the other companies that contemplate bringing dredges into the country have installed their plants there is every reason to believe that there will be a considerable increase in the annual output of gold in this Territory.

I have the honour to be, sir,
Your obedient servant,

E. C. SENKLER,
Acting Gold Commissioner.

FINANCIAL STATEMENT of the Gold Commissioner's Office from April 1, 1907, to March 31, 1908.

RECEIPTS.

To free miners' certificates		$ 71 25
Placer—		
To grants	$ 13,980 00	
To renewals	68,319 00	
To relocations	5,870 00	
To registered documents	12,356 00	
To abstracts	59 00	
		100,584 00
Quartz—		
To records	$ 2,590 00	
Certificates of work	747 50	
Certificate of partnerships	65 00	
Registered documents	660 00	
Lieu of assessment	200 00	
Certificate of improvements	27 50	
Acreage	459 60	
Abstracts	2 50	
		4,752 10
Sundry Accounts—		
To water grants	$ 1,225 00	
Advance deposit	1,907 98	
Hydraulics	3,464 67	
		6,597 65
Duncan—		
To placer grants	$ 1,150 00	
Renewals	3,606 00	
Relocations	1,070 00	
Registered documents	745 00	
Quartz grants	5 00	
Quartz certificate of partnership	2 00	
Quartz registered documents	5 00	
Water grants	25 00	
		6,608 00
Sixtymile—		
To placer grants	$ 50 00	
Renewals	2,010 00	
Relocations	220 00	
Registered documents	343 00	
Quartz records	10 00	
		2,633 00
Total		$121,246 00

DISBURSEMENTS.

By Receiver General	$ 119,140 52	
Gold Commissioner's suspense account	197 50	
Balance account	1,907 98	
		$121,246 00

COMPARATIVE STATEMENTS.

Returns Gold Commissioner's Office.

——	Year ending March 31, 1907.	Year ending March 31, 1908.	Increase 1908.	Decrease 1908.
	$ cts.	$ cts.	$ cts.	$ cts.
Free Miners' Certificates	10,999 25	71 25	....	10,928 00
Placer Grants	19,630 00	15,180 00	....	4,450 00
Renewals	44,115 00	73,935 00	29,820 00	....
Relocations	10,200 00	7,160 00	....	3,040 00
Registered Documents (Placer)	9,891 50	13,444 00	3,552 50	....
Certificate of Partership	310 00	....	....	310 00
Certificate of Work	1,556 00	....	....	1,556 00
Abstracts	74 75	59 00	....	15,75
Amended Applications	30 00	....	....	30 00
Water Grants	1,140 00	1,250 00	110 00	....
Hydraulics	1,764 50	3,464 67	1,700 17	....
Quartz Records	1,125 00	2,605 00	1,480 00	....
Quartz Registered Documents	387 50	665 00	277 50	....
Quartz Certificate of Work	467 50	747 50	280 00	
Quartz Certificate of Partnership	35 00	67 00	32 00	....
Quartz Lieu of Assessment	100 00	200 00	100 00	....
Quartz Certificate of Improvements	60 00	27 50	....	32 50
Quartz Acreage	1,254 32	459 60	....	794 72
Quartz Abstracts	....	2 50	2 50	....
Advance Deposits	1,907 98	1,907 98	....	....
	105,048 30	121,246 00	37,354 67	21,156 97
Net Increase	....	....	16,197 70	

RECAPITULATION.

FINANCIAL Statement Gold Commissioner's Office, Year ending March 31, 1908.

	Free Miners Certificate Receipts.	Placer Grants.	Renewals.	Relocations.	Registered Documents.	Abstracts.	Water Grants.	Hydraulics.	Quartz Records.	Quartz Registered Documents.	Quartz Certificate of Work.	Quartz Certificate of Partnership.	Quartz Lieu of Assessment.	Quartz Certificate of Improvem'ts.	Quartz Abstract.	Quartz Acreage.	Advance Deposit.
	$ cts.	$	$	$	$	$	$	$ cts.	$	$	$ cts.	$	$	$ cts.	$ cts.	$ cts.	$ cts
Dawson	71 25	13,980	68,319	5,870	12,356	59	1,225	3,464 67	2,590	660	747 50	65	200	27 50	2 50	459 60	
Duncan	......	1,150	3,606	1,070	745	......	25	....	5	5	......	2	......	......	......	......	....
Sixtymile	......	50	2,010	220	343	......	......	....	10	......	......	......	......	......	......	......	....
Advance Deposit	......	......	......	......	......	......	......	....	......	......	......	......	......	......	......	......	1,907 98
	71 25	15,180	73,935	7,160	13,444	59	1,250	3,464 67	2,605	665	747 50	67	200	27 50	2 50	459 60	1,907 98

LOCATIONS DAWSON DISTRICT YEAR ENDING MARCH 30, 1908.

Name of Creek.	Locations.				Relocations.			
	Creeks.	Hills and Benches.	Rivers.	Bars.	Creeks.	Hills and Benches.	Rivers.	Bars.
"Clear Creek," Stewart River	13	15	......	......	13	......	......	......
Yukon River	......	27	27	16	......	......	11	......
Yukon River, small tributaries	46	22	......	......	16	......	......	......
Indian River	......	......	308	......	......	......	......	......
Indian Creek	55	......	......	......	......	......	......	......
Forty-mile River	......	......	16	......	......	......	3	......
Small tributaries, 40-Mile River	30	......	......	......	4	......	......	......
Moose Creek, 40-Mile River	77	......	......	......	13	......	......	......
Fall Creek, 40-Mile River	99	......	......	......	......	......	......	......
Herbert Creek, 40-Mile River	23	......	......	......	......	......	......	......
Dominion Creek	29	40	......	......	25	52	......	......
All Gold	......	2	......	......	2	......	......	......
Klondike River	......	42	42	......	1	......	6	......
Small tributaries, Klondike River.	40	......	......	......	1	......	......	......
Thistle Creek	10	......	......	......	28	......	......	......
Black Hills Creek	195	36	......	......	44	......	......	......
Quartz Creek and tributaries	63	22	......	......	98	24	......	......
Barker Creek	5	......	......	......	13	......	......	......
Hunker Creek	11	17	......	......	42	39	......	......
Sulphur Creek	11	......	......	......	26	1	......	......
Gold Run Creek	1	2	......	......	11	12	......	......
Stewart River	......	......	8	......	......	......	4	......
Twelvemile River	......	......	9	......	......	......	......	......
Bonanza Creek	13	16	......	......	33	32	......	......
Eldorado	2	......	......	......	19	13	......	......
Selwyn Creek	6	......	......	......	1	......	......	......
White River	......	......	......	1	......	......	......	......
	729	241	410	17	390	173	24	......

1,397 Locations. Among these were many so-called discoveries, but in reality are only first locations on abandoned creeks. Also, 587 Relocations during the year.

THE MINING OPERATIONS IN THE YUKON TERRITORY FOR THE YEAR 1907-1908.

During the last year much grouping has been done whereby a large number of placer mining claims are being operated with one plant. Although the number of operations has decreased the scale of the work has materially increased. You will notice, in another part of this report, that there are 22 separate operations conducted on the hills of Bonanza creek. This does not mean that there are only 22 claims in operation, but that each operation is a plant of large magnitude operating on a group of placer claims ranging from 10 to 100 in number.

This arrangement has been found necessary to work the many claims already worked by the placer mining methods at a profit, this practice has been general on all the large gold-bearing streams situated within the Dawson mining district.

The hydraulicing and dredging methods are the two large scale methods of mining in vogue in this Territory. The former is applicable to hillside diggings, while the latter is confined to valleys and creek bottoms. As either of these large methods require large areas of ground to justify the installation of a large plant, it is obvious that its application is only feasible when a large number of placer mining claims can be grouped together.

The individual mining operations are confined to the lower parts of Dominion and Sulphur creeks; the whole of Quartz and Black Hills creek. The individual mining operations on Bonanza, Eldorado and Hunker creeks are nearly at an end; the whole being rapidly absorbed into groups of claims upon which large plants are being installed.

According to the regulations the work done on a claim outside its boundaries, with intent to work said claim, is deemed work on that claim. This privilege caused the largest portion of the principal gold-bearing creeks to remain idle until the large installations which are now in progress are completed. From the present outlook it appears to me that the same condition will prevail for one more year, after which an increase of output can be expected.

NEW DISCOVERIES.

Two new discoveries were made during the last year, viz.: one on Little Blanche creek and the other on Black Hills creek.

It was not surprising to find pay on the benches of Little Blanche creek, as pay had already been found in the immediate vicinity, the chief importance lies in the fact that it was situated within the limits of a hydraulic concession which was lately cancelled by the Department of the Interior for non-representation, and had it not been opened to the public it is possible that this pay would not have been found for a long time to come.

The other discovery, on Black Hills creek, is by far the most important as it opens up a part of the Stewart River district which has laid dormant for the last seven years.

This stream, a distance of 60 miles from Dawson, is a tributary of the Stewart river, entering it at a point, on its right limit, 35 miles above its mouth.

All supplies are freighted over the snow at a cost of four cents per pound, any freight needed during the summer months will go by steamer as far as the mouth of the stream. There is at present stage connections twice a week.

There are 252 creek and 100 hillside claims located on this stream and about 50 other claims located on some of the tributaries.

The work going on is still in its initial stage and not more than prospecting is being done. Some winter dumps are being taken out, but no output of any great importance can be expected this year, the results at the spring clean-ups will determine to a material degree the importance of this stream as a gold producer.

At present there are about 50 separate individual plants in actual operation; some are taking out dumps, while the others are merely prospecting their claims.

THE INFLUENCE OF NEW MINING METHODS.

Where the mining conditions are inimical to dredging, such as hard bed rock and frost, and to hydraulicing, where there is not sufficient grade for the disposal of the tailings, a method has been devised by the engineers of the Yukon Gold Company whereby shallow creek gravels can be operated on a scale to compare favourably with that of the dredge. The main object of the method is to provide grade for the removal of the tailings collected into a sump-hole in the creek bottom, which are produced from hydraulicing. This mechanical device is an endless chain of buckets which elevate the material from the sunp-hole into sluices.

This method was once introduced on Eldorado creek, but on account of the lack of water under pressure and the prohibitive cost of fuel for power it was abandoned. As, in this instance, water is plenty and power is cheap, therefore, we should look for success, and if so, the largest and most important parts of Bonanza and Eldorado creeks will be operated in that way. As the method develops itself it is probable that many of the claims which cannot be worked by dredging will be operated in the future, provided they are situated within the radius of hydro-electric transmission and in the vicinity of water under pressure.

This method should be classified as an 'open-cut' method of mining, which is applicable to operate shallow creek diggings where water under pressure and cheap power are both available.

There are three of such already installed on Bonanza creek, and I must say that the operations, which will be conducted this year for the first time, will be watched closely.

COAL.

All the coal produced in the Territory comes from two mines, viz., the Sourdough and Tantalus coal mines.

There has been no demand for coal on the creeks; so far the production has been used for domestic purposes, the Dawson Electric Light and Power Company and some of the White Pass and Yukon Transportation Company's steamers.

Sourdough Coal Mines.

These mines are situated on the Yukon river, about 50 miles below Dawson. They are controlled by the Dawson Electric Light and Power Company.

The output of the mines for the last year was 5,200 tons; the prices charged in Dawson per ton for domestic purposes was from $12 to $15, delivered at the residences.

The Tantalus Coal Mines.

These mines are situated on the Yukon river a few miles from Carmack's post, or a distance of 215 miles from Dawson.

These mines are controlled by the White Pass people, who use the total production for their steamers, operating on the Yukon river, and for domestic purposes in Dawson.

The output for the last year was 7,233 tons; the prices charged in Dawson for domestic purposes range from $15 to $18 per ton, delivered at the residences.

WOOD.

Wood is still the chief fuel for mining purposes, but its need is growing less on account of large installations being erected whereby no fuel is needed. Its chief use in the Dawson mining district is for thawing. The cost of wood per cord varies with the locality in which it is used, also depending on the distance it has to be hauled. On the creeks the cost of wood per cord delivered on the claims is as follows:—

Bonanza creek, lower part	$10 00		
Bonanza creek, upper part	12 00		
Eldorado creek	12 00	to	$17 00
Hunker creek, per cord	7 50	to	11 00
Sulphur creek	8 00	to	11 00
Dominion creek, upper part	12 00	to	13 00
Dominion creek, lower part	7 00	to	8 00
Gold Run creek	8 00		

You will find herewith attached a statement showing the number of claims, their location, in operation during the summer months. Only a small percentage of them are operated during the winter months.

The Mining Operations in the Yukon Territory during the Year 1907-1908.

Name of District and Stream.	Name of Company.	Description of Claims.	Method.	Remarks.
Dawson Mining District.				
Klondike River	Yukon Gold Company	Benches and hillside claims	Hydraulicing	There are three individual plants in operation on the left limit of the Klondike river. These outfits work by ground-sluicing and hydraulicing. The other claims in this locality are owned by the Yukon Gold Company and will be idle for another year.
	Bonanza Basin G. D. Co.	River valley	Dredging	
	C. K. Mining Company	River valley near Bear creek	"	
	Grotschier Conces.	Bench gravels	Hydraulicing	
Bonanza Creek	Yukon Gold Company	Creek claims from No. 104-A to No. 85 below discovery.	Dredging	This company has installed four dredges on these claims, and they can be counted as producers. The creek claims, from No. 85 to 30 below Discovery, are now idle and will be for another year.
	Yukon Gold Company	Benches and hillside claims bordering on the right and the left limit of the creek.	Hydraulicing	This company has acquired, with few exceptions, all the hillside and bench claims and are operating groups of claims of from 10 to 100 in number, as follows:—King Solomon Hill, Orofino Hill, American Hill, Magnet Hill, Monte Christo Hill and Bunker Hill. All the claims situated on Gold Hill and Cheechacho Hill were idle during the last year but will be operated next year.
	Yukon Gold Company	Creek claims from No. 30 to No. 10 below Discovery and from No. 3 to No. 6 above Discovery were idle, but will be worked next year.	Electric lift	Although none of these claims have produced the last year a very large amount of work was done on them in the way of preparing the ground for the method to be employed. There were a few individual claim owners who operated, which will be mentioned later.
	Lewis River Company	Discovery and two other claims	Dredging	This company operated on Discovery, No. 1 above and No. 1 below, during the first part of the year, after which they moved the dredge to No. 6 below Discovery and operated for the balance of the season.
	Cook, *et al.*	Hill and bench gravels	Hydraulicing	A group of claims on Boulder Hill.
	Bonanza Creek Gold Mining Co.	Hills and benches	"	A group of claims on Adams Hill.
	Individual operators	Creek and hill claims	Placer mining	There were fifteen creek operators and eleven hillside operators who operated the whole season.
Lovett Gulch	Yukon Gold Company	Creek, hill and bench claims	Hydraulicing	The majority of creek, hill and bench claims on this stream are owned by this company. These claims were idle during the year and will remain so until the big ditch is finished.
	Canadian H. and D. Company	Bench claims	"	A group of claims which were once worked by the placer mining method.
	Individual operators	"	Hydraulic-placer	There are four individual outfits operating on a small scale.
Trail Gulch	Yukon Gold Company	Creek, hill and bench claims	Placer mining	This company controls all the placer mining claims on this stream with two exceptions. These were idle last year and will be for another.
	Individual operators	Creek and bench claims	"	Two outfits were operating on a small scale.
Adams Creek	Bonanza Creek G. M. Company	Hydraulicing, hill claims	Hydraulicing	All the hill claims bordering on the left limit of the stream are worked by this company.

	Individual operators	Creek claims	Placer mining	Three plants were operating in the creek.
Skookum Gulch	Yukon Gold Company	Creek and hill claims	Hydraulicing	A group of claims. They were idle last year.
	Individual operators	Creek claims	Placer mining	Three outfits were operating last year.
Eldorado Creek	Yukon Gold Company	"	"	All the claims owned by the company were idle.
	Individual operators	"	"	There were twelve producing outfits on the creek.
French Gulch	Otto Brener	Hill and bench claims	Hydraulicing	A group of claims on French Hill.
	Individual operators	Creek claims	Placer mining	Three individual outfits.
Gay Gulch	"	"	"	Two outfits operating about twelve claims.
Victoria Gulch	"	"	"	Three outfits operating ten claims.
Homestake Gulch	"	"	"	Two outfits operating four claims.
Magnet Gulch, American Gulch, Monte Christo Gulch and Fox Gulch.	Yukon Gold Company	"	Hydraulicing	All the creek claims situated in these gulches are being worked by three hydraulic plants, which operate bench claims in the vicinity.
Hunker Creek	"	"	Dredging	This company has three dredges, one at the mouth of the creek, one on the Anderson concession and one at No. 37 below Discovery.
	Yukon Gold Company	Bench claims	Hydraulicing	A group of claims situated on Paradise Hill.
	Otto Brener	Hill and bench gravels	"	Williams' hydraulic concession.
	DeBlegier and Company	Creek, hill and bench claims	"	A group of claims on Temperance Hill.
	Delhie and Company	Hill and benches	"	A group of claims on Delhie Hill.
	A. Larson, individual	Hill and bench claims	"	A group of claims on Temperance Hill.
	Mr. Elliott, individual	"	"	A group of claims on Paradise Hill.
	Mr. Kirkpatrick, individual	Creek claims	Placer mining	Two groups of claims below and above Discovery.
	Yukon Gold Company	"	Preparatory work	A large number of creek claims were idle last year and will be until the water system is completed.
	Individual operators	Creek and bench claims	Hydraulic and placer	There were twenty-six individual mining plants in operation in the creek bed and nine operating hills and benches. Each plant represents a number of claims formed into groups, each group being kept in good standing by the work of the plant. In each instance only one claim is worked at a time.
Last Chance Creek	Eilbeck and Collins	Hill and bench claims	Hydraulicing	A group of claims situated opposite No. 10 A. B.
	Dolan, *et al.*	"	"	A group of claims opposite No. 15 A. B. Dis.
	Mahon and Abraham	Creek, hill and bench claims	Hydraulic and placer	A group of claims over seventy-five in number.
	J. S. Day	Hill and bench claims	Hydraulicing	A large group of claims near mouth of creek.
	Individual operators	Creek, hill and bench claims	Placer mining	Three outfits are operating in the creek and five are operating on the hillsides.
Gold Bottom Creek	"	Creek claims	"	Three outfits are drifting.
80 Pup	"	Creek, hill and bench claims	Drifting, hydraulic.	Many of these claims are owned by operators on Last Chance creek who work the whole as a group.
Mint Gulch	"	Creek claims	Placer mining	Operating by the primitive method of drifting.
Dominion Creek	"	"	"	Five outfits are operating above Upper Discovery; eight outfits below Upper Discovery; twenty-one outfits below Lower Discovery. These are situated in the creek.
	"	Hill and bench claims	Hydraulicing	Seven plants are operating hill claims.
Caribou Creek	"	Creek claims	Ground sluicing	Only one outfit is working.
Gold Run Creek	Crueger Gold Run Company	"	Placer mining	Eight claims belonging to this company are being operated and three individual outfits.
Sulphur Creek	Individual operators	"	"	There are about twenty-five outfits working and producing and as many prospecting. There are no large companies on this creek.
Quartz Creek	"	"	"	There were eleven outfits drifting.
	"	Hills and benches	"	There were thirty outfits operating on these hills and benches. The most of the work done on this is done on bench gravels. Population, about 300.

The Mining Operations in the Yukon Territory during the Year 1907-1908.

Name of District and Stream.	Name of Company.	Description of Claims.	Method.	Remarks.
Dawson Mining District.				
Indian River Valley	Indian River Devel. and D. Co.	River claims	Dredging	A dredge was put on this property last year.
Stewart River District.				
Duncan Creek	Individual operators	Creek claims	Placer mining	About twelve outfits were operating. Many of the owners are waiting for the results of the pumps.
Hiatt Creek	"	Creek and hill claims	"	About ten outfits were working during the year.
Clear Creek	"	Creek, hill and bench claims	Placer, ground-sluicing.	One outfit will be hydraulicing soon; three have been ground-sluicing and two are drifting.
Black Hills Creek	"	" "	Placer mining	About fifty outfits are operating and prospecting. The population on the stream is about 100.
Henderson Creek	"	Creek claims	"	Seven outfits are operating at present.
McQuesten River	"	Hill claims	"	Only two outfits are working at present.
Haggart Creek	"	Creek claims	Ground-sluicing	One outfit is ground-sluicing ten claims.
Barker Creek	"	Creek and hill claims	Placer mining	Six outfits drifting.
Ledge Creek and Steep Creek	"	Creek claims	"	Only a few people on these streams.
Ballarat Creek	Ballarat Hydraulic Company	"	Hydraulicing	A hydraulic concession.
Thistle Creek	Individual operators	Creek and hill claims	Placer mining	There are about thirty operators on the creek.
The Salmon District.				
Livingston Creek	"	Creek claims	"	There are about fifteen outfits operating on this stream and its tributaries. Population, about 125.
The Sixty-Mile District.				
Miller Creek	Miller Creek concession	"	Hydraulicing	It operated very little during the last year; they are preparing the ground for dredging.
Glacier Creek	Individual operators	"	Placer mining	There are about sixty operators on this stream.
10-Mile Creek	Syndicat Lyonnais	Bench gravels	Hydraulicing	A hydraulic concession.

OFFICE OF THE CROWN TIMBER AND LAND AGENT
OF THE YUKON TERRITORY,
DAWSON, April 2, 1908.

ALEXANDER HENDERSON, Esq.,
Commissioner of the Yukon Territory,
Dawson, Y.T.

SIR,—I have the honour to submit my report for the twelve months ending March 31, 1908, accompanied by the following:—

Statement of revenue in the timber branch.
Statement of revenue in the lands branch.
Statement of timber and hay permits issued.

The revenue in the timber branch amounted to..	$17,712 60
The revenue in the lands branch amounted to..	8,505 00
Total for twelve months to March 31, 1908..	$26,217 60

The total revenue for nine months to March 31, 1907 was $21,422.46.

It will be noticed that the revenue in both branches is keeping up pretty well. The past winter was extremely mild throughout and considerably less wood was consumed for fuel. It is likely a large quantity of wood brought to market this winter will go over to next year.

Of the $8,505 Dominion lands revenue, $5,003.40 was for purchase price of coal lands and interest, and $400 for survey fees for coal lands.

Coal is coming to the front rapidly. Royalty was paid on 15,433 tons, about triple the amount of last year; 7,233¾ tons of this was mined at Tantalus, the balance at Coal creek. The greater portion of the Tantalus coal is used by the White Pass boats plying between Dawson and Whitehorse, and the Klondike Mines Railway; and the greater portion of the Coal Creek coal by the electric light plant in Dawson, which is owned by the holders of the Coal Creek coal mine. The price of coal for domestic use in Dawson is $16 per ton.

Considerable coal land has been taken up on Indian river, 6 miles below Quartz creek, which has not been proven to any extent yet. A short distance above, the McKinnon brothers have been tunneling for several years through hard rock in a hopeful search for coal of better quality than that heretofore discovered.

Mr. C. E. Miller, the greatest discoverer and promoter of the coal industry in the Yukon, will commence operations in May at his latest discovery on Tantalus butte, directly across the river from his previous discovery at Tantalus. Great things are expected of this coal, which Mr. Miller claims to be of the best quality yet discovered.

Operations were carried on all last summer at the Five Finger coal mine, the owners of which are confident that by tunneling through the hard rock they will yet strike coal of the best quality.

The Tantalus coal mine will operate this summer on as large, if not a larger, scale than last year. Theirs is the best coal mined so far. The output of coal is increasing rapidly each year.

The Coal Creek people were driven out by water last season and their future movements are uncertain.

Wood is more difficult to get each season. That marketed in Dawson the past winter was very small and dirty. It may be said in the vicinity of Dawson and for 75 miles up the Klondike the available timber is confined to the timber berths. Along the Yukon the nearest wood available outside of timber berths is two miles from the river. The average price for wood from Whitehorse to Dawson, where it is mostly all used for steamboats, is \$4.50 to \$6.50 per cord, and from Dawson to Eagle, Alaska, \$8. Wood delivered in 16-foot lengths from the raft at Dawson goes at \$8.50 to \$10, and that hauled from the wood in winter sells at \$10 per cord. The average price in Dawson for wood cut into stove lengths is \$16.

The sales of the three mills in Dawson during the year amounted to 3,488,360 feet b.m. of lumber, and 547¾ cords of wood. Reports and payment of royalty on a portion of this is still outstanding, awaiting the return of officers of two of the mills this month.

The price for lumber has lately been \$45 to \$50 per thousand, but as the Northern Lumber Company has gone out of business and the Yukon Saw Mill Company is preparing to take over the Klondike Mill Company this summer, the average price will be about \$60. Of course for large contracts to the big mining companies, and they utilize 75 per cent of the lumber sold, the price would be lower. Owing to the activity of these mining companies a great deal of lumber is being used.

The Yukon Gold Company erected a mill at Twelvemile, below Dawson, to cut flume lumber in connection with the construction of the Acklen ditch. From March 26, 1906, to October 28, 1907, 7,192,894 feet b.m. was manufactured, 4,009,496 feet of which was on hand at the latter date. No revenue is derived from this whatever.

It is impossible to state how many timber berths are in operation, as some of the licensees leave here in the fall and are not seen again until spring, when possibly they land in Dawson with a raft. Probably five parties are operating on the Klondike, and about three or four on the Yukon.

The farmers were mostly pleased with their crops last season. All vegetables thrived splendidly and a great improvement was shown in the quality of potatoes, those grown at some points excelling the imported. Five homesteads were granted, and an additional dozen or more applied for. Most of the applications are from wood cutters, who find time to raise crops in the summer at the same places where they cut their wood in the winter.

The work of the office will be simplified considerably by doing away with two inspection trips each summer from Whitehorse to Dawson. Mr. Povah has worked out a new system of checking the wood consumed by steamboats in the Territory, which will save the time he is taken away from the office to make the inspections, as well as the expense of the trips. The system will be put into working order this summer and all the old business cleared up.

Rentals charged for waterfront at Dawson have been so materially reduced and so much of the frontage has been relinquished, that what used to be a great source of revenue has fallen off to next to nothing.

The office continues to be conducted in a most capable manner by Mr. W. F. Povah, with entire satisfaction to the public. Since taking charge of the office he has assumed the duties of former chief timber inspector D. A. McRae, of the accountant, clerks—in fact he does all the work previously done by a very large staff, creating, as stated by Mr. Gosselin in the last annual report, 'a saving of over \$1,000 per month.'

Mr. Charles Sylvestre is a good and conscientious timber inspector and does his work well. He keeps a check on all the wood brought to Dawson.

Respectfully submitted,

E. C. SENKLER,
Acting Crown Timber and Land Agent.

SESSIONAL PAPER No. 25c

Crown Timber Branch.

	Royalty.	Timber Permits.	Seizures.	Hay Permits.	Coal Royalty.	Total.
1907.						
April	1,226 99	2,369 50	575 00	....	....	4,171 49
May	1,731 16	413 25	127 50	29 00	40 00	2,340 91
June	951 14	182 32	91 00	8 00	10 00	1,242 46
July	441 61	921 37	45 50	70 00	39 05	1,517 53
August	178 63	315 46	12 00	27 00	275 48	808 57
September	208 05	431 50	15 00	....	1,006 90	1,661 45
October	1,210 44	1,083 00	61 00	....	126 90	2,481 34
November	686 72	415 35	8 00	....	41 45	1,151 52
December	141 28	610 00	10 00	....	3 60	764 88
1908.						
January	167 64	377 75	....	....	....	545 39
February	119 65	427 50	21 50	....	....	568 65
March	148 41	310 00	....	....	....	458 41
	7,211 72	7,857 00	966 50	134 00	1,543 38	17,712 60

Dominion Lands Branch.

	General Sales.	Rentals.	Registration Fees.	Survey Fees.	Homestead Fees.	Total.
1907.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ sct
April	650 00	2,015 00	4 50	200 00	....	2,869 50
May	12 89	13 63	2 00	....	....	28 52
June	125 00	....	....	....	....	125 00
July	488 72	365 30	....	100 00	....	954 02
August	3,624 97	....	17 00	100 00	....	3,741 97
September	....	12 91	6 00	....	30 00	48 91
October	....	51 17	6 00	....	....	57 17
November	134 41	50 50	....	....	10 00	194 91
December	160 00	....	....	....	....	160 00
1908.						
January	15 00	5 00	....	....	10 00	30 00
February	5 00	....	....	....	....	5 00
March	290 00	....	....	....	....	290 00
	5,505 99	2,513 51	35 50	400 00	50 00	8,505 00

PERMITS issued at Dawson during the twelve month ending March 31, 1908.

No.	Logs—B.M.	Houselogs.	Cordwood.	Hay.
	Feet.	Feet.	Cords.	Tons.
8	244,000	....	....	....
2	....	8,250	....	....
72	....	....	9,048	....
15	....	....	....	102

SURVEY OFFICE, YUKON TERRITORY,
DAWSON, Y.T., April 6, 1908.

Hon. ALEXANDER HENDERSON, K.C.,
Commissioner, Y.T.

SIR,—I have the honour to submit the following report of the operations of the Survey Department for the year ending March 31.

Mr. Gibbon and myself have been the only members of the staff during the past year.

In June and July Mr. Gibbon established base lines on a portion of the Sixtymile river and on Miller and Glacier and Little Gold creeks in the Fortymile district. In August Mr. Gibbon was employed in the office and in making some small surveys for the Gold office. From the middle of September to April first he was away on leave of absence.

Returns for none of the surveys made by Mr. Gibbon since the spring of 1905 have as yet been completed, in consequence of which I asked to have Mr. Bennet transferred to this office, which was done on the first of this month. I hope now to have all the back work brought up to date.

Plans and returns of the following surveys were filed in this office during the past year:—

Group lots including Quartz claim surveys	75
Advertised placer claims	17
Base lines and traverses	4

These include the surveys made by surveyors in private practice in the Territory.

I have the honour to be, sir,
Your obedient servant,

C. W. MACPHERSON,
Director of Surveys, Y.T.

OFFICE OF THE ASSISTANT GOLD COMMISSIONER,
WHITEHORSE, Y.T., May 4, 1908.

ALEXANDER HENDERSON, Esq.,
Commissioner of the Yukon Territory,
Dawson, Y.T.

SIR,—I beg to submit the following report respecting the conditions existing in the Southern Yukon during the fiscal year 1907-8, comprising the Whitehorse, Conrad and Kluane districts.

WHITEHORSE DISTRICT.

The promised development of a year ago of the extensive copper showing in this district was unfortunately greatly curtailed and in most instances shut off by the fall in the price of copper and the accompanying financial depression. As a consequence the shipment of ore, which was assuming fair proportions, had to be entirely discontinued, while development operations were reduced to a minimum. However, things are beginning to look up again, and the next few months may set operations moving briskly once more. The Copper King mine has been fitted with suitable boiler, hoist and compressor and it is likely will start work at an early day. The general development of the belt may, however, be said to await the completion of the spur or branch of twelve miles in length now being put in by the White Pass Railway, and which when completed will closely serve nearly all the supposedly good claims on the range. The railway company are already actively at work on this spur and will likely have it practically completed early in the coming summer. It will then, it is hoped, be found profitable to ship ore even at the prevailing low price of copper. The Arctic Chief and War Eagle claims are already preparing for this by working their properties in a small way, and it is hoped they will be joined by the Copper King, Valerie, Pueblo and others, later.

The total shipments of copper ore from this belt, last season, were approximately as follows:—

	Tons.
Grafter	2,000
Arctic Chief	300
Copper King	300

For a time the Grafter was operated quite extensively and with very bright prospects by the owner, Mr. Robert Lowe. A large body of ore, averaging 6 per cent copper with steady gold and silver values of $2.50 per ton, was struck, but notwithstanding this the fall in the price of copper from 24 to 12 cents per pound was altogether too great to permit of operations being continued without serious loss. At the time the mine closed down the shaft had reached the 100-foot level, and the mine foreman, a practical and experienced miner, unhesitatingly declared that he had then over twelve thousand tons of good shipping ore in sight. Under the old prices of copper, and with the railway spur completed, this alone would undoubtedly have paid for the mine outright.

It seems a pity that greater depth has not been reached on the claims on this belt. In almost every case where the work has gone down the ore has been found to well maintain its values and to materially increase in extent.

The placer diggings at Livingstone creek are in about the same position as last year, nothing very striking having occurred. The production was somewhat less than the previous season, partly accounted for by a washout on the working of the Livingstone creek syndicate, by which a loss of about three weeks in the best part of the season was entailed. The total production of this camp for the year was somewhat less than $60,000. However, the general outlook appears to be brightening. Good pay appears to exist on both Summit and Cottoneva creeks, but production is hampered and delayed by the presence of water in the gravels in large quantities, necessitating the use of powerful and costly machinery in order to reach bedrock anywhere. The average depth to bedrock is also very great. Mr. G. A. Singer, on behalf of certain Seattle capitalists, sunk a shaft on No. 11 below Livingstone creek to a depth of 140 feet, but was greatly hampered throughout by the volume of water, and finally had to abandon the work through that cause. It is expected that larger pumps will be put in and bedrock reached without fail. The gravel encountered in sinking was found to contain small values throughout. A water system from Mendocino creek, where the supply is large, is projected and it is hoped will enable promoters to demonstrate the value of the ground. The gold in this camp is very heavy, mostly nuggets, and is consequently nearly all deposited on bedrock.

WHITEHORSE TIMBER AND LANDS.

Nothing unusual has developed in connection with timber and Dominion lands during the year. Four homesteads have been applied for under the new homestead regulations. There are no saw-mills operating in this district.

I append a table, No. 1, showing the collections made from all sources in this district during the year. The total is $15,109.71, and includes collections from mining, timber, Dominion lands and gold royalty.

CONRAD DISTRICT.

Matters have been quiet in the Windy Arm section also. No operations of any kind have been in progress for several months past. However, the prospects are better for the future. The Conrad Consolidated Co. have purchased and are about to install a concentrating plant capable of handling 60 tons of ore per day, and as it appears there is already a large quantity of good ore on hand, no doubt the product from the new venture will quickly become very considerable. One shipment of 100 tons of sacked ore was made from the Venus claim last summer, which I am assured averaged fully $50 per ton.

The Wheaton and Watson valleys still maintain their hold on the prospectors, though operations have here also been greatly restricted through lack of funds. However, a good road has been built through the Watson valley, and it is hoped and expected that several of the best showings will be thoroughly tested at an early day.

A shipment of 18 tons of silver lead ore from the Tally-Ho group is now on the way to the smelter, but the result has not been ascertained up to this time. It is expected that it will net between $80 and $90 per ton. Mr. H. W. Vance, of the Conrad Consolidated Mines Co., has secured an option on three claims in the Big Bend group, and will likely try them out thoroughly. The values here are perhaps greater than have been found elsewhere in this section. One assay gave $296 to the ton, and the average, I am assured, may fairly be given as between $50 and $100. Unfortunately the extent of this valuable ore has not yet been definitely ascertained.

The best assays have shown principally gold values, though silver in considerable quantities is also present in every case. Col. W. S. Thomas, who has options on a number of what appear to be the best claims in this section, performed about 100 feet of rock work last year with encouraging results. He also ran several small tunnels on the Tiger group, situated about six miles south, and encountered several fair sized veins of valuable ore. On the whole I think that this is a most promising district.

The total collections for this district are $2,318. It is all on account of mining dues. I attach a table, No. 2, giving the monthly returns of this.

KLUANE DISTRICT.

The collections for this district for the year total $3,358, and it is all on account of mines. The prospects for placer mining have about maintained the old level, the main production being from Fourth of July, Bullion, Sheep, Burwash and Arch creeks. The season was both cold and short, and the production suffered in consequence. A couple of small hydraulic plants have been installed at a point six or seven miles up Sheep creek, and it is hoped will be operated successfully the coming summer. The ground is shallow, only two or three feet in some cases, and pay is said to be present over quite an area. All the other productive creeks are mainly worked by shovelling the gravel from the creek bed into boxes erected at the point of operation, the water for which is usually obtained from wing dams farther up. Good pay has been found at one or two points by this method on Fourth of July and Burwash creeks, but the work can only be carried on during the most favourable summer months. The process, too, is most laborious, and the quantity of gravel handled necessarily small.

The copper showings on Burwash creek appear to promise well and will, no doubt, yet be heard from. But of course nothing can be looked for from this source until better transportation facilities are secured. The Jacquot Brothers are about to bring out a couple of tons of the ore from their claims on Burwash, which will at least demonstrate its quality. The cost of this shipment will necessarily be heavy. It has to be transported by sleigh and wagon nearly 200 miles. Several prospectors have been in the White River country since my last report, but so far as I can learn have discovered nothing startling beyond what has been previously reported. Indeed, so far as copper is concerned, I cannot but conclude, as the result of inquiries made upon every available occasion, that nothing has been yet shown to exist on White River proper that will compare with the showings discovered by Jacquot Brothers on Burwash and Tatamagouche creeks, Kluane lake.

There has recently been much talk of a road being built from Dawson to the head of White river. I feel sure the construction of such a highway would be a mistake, both because nothing has yet been discovered that would warrant such an expenditure, and also because the natural route is from Whitehorse through the Kaskawulsch and Kluane valleys, three-fifths of which is already served by a fairly good wagon road. I here also attach a table, No. 3, giving details of the collections made.

I have the honour to be, sir,
Your obedient servant,

R. C. MILLER,
Assistant Gold Commissioner, &c.

APPENDIX TO REPORT OF ASST. GOLD COMMISSIONER MILLER.

STATEMENTS

OF

FEES COLLECTED AT WHITEHORSE, CONRAD AND KLUANE FOR FISCAL YEAR 1907-1908.

TABLE NO. 1.—STATEMENT showing the Fees Collected in the Office

Month.	Placer Mining.					Quartz		
	Grants.	Reloc.	Ren'ls.	Reg. Doc.	C. of P.	Grants.	C. of W.	C. of P.
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
April	....	....	30 00	2 00	....	670 00	10 00	2 50
May	....	80 00	45 00	14 00	....	330 00	62 50	7 50
June	10 00	30 00	15 00	14 00	....	265 00	47 50	2 50
July	....	10 00	75 00	31 00	....	175 00	45 00	7 50
August	30 00	30 00	825 00	14 00	8 00	30 00	50 00	12 50
September	20 00	....	120 00	18 00	....	110 00	42 50	5 00
October	40 00	140 00	105 00	11 00	....	35 00	45 00	0
November	....	....	....	....	....	60 00	60 00	....
December	50 00	30 00	30 00	4 00	....	90 00	42 50	5 0..
January	20 00	40 00	....	6 00	....	20 00	17 50	10 00
February	....	....	....	16 00	....	5 00	55 00	2 50
March	....	90 00	30 00	42 00	....	35 00	50 00	0
Total	170 00	450 00	1275 00	172 00	8 00	1,825 00	527 50	55 00

of the Asst. Gold Commissioner, Whitehorse, for Fiscal Year 1907-08.

Mining.		Water.	Timber and Land.			Gold Royalty.		Total.
Reg. Doc.	P. in lieu.	Rights.	D. L. Rec.	Wood.	H'tead.	Royalty.	Free.	
$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
316 00	100 00	....	2,970 38	....	....	....	....	4,100 88
25 50	....	....	512 50	55 00	....	....	....	1,132 00
87 00	....	....	1,083 12	....	....	111 72	1 00	1,666 84
39 00	200 00	....	267 83	30 00	....	395 15	1 00	1,276 48
25 50	....	....	....	....	40 00	181 15	....	1,246 15
20 00	....	....	613 74	140 00	....	62 95	....	1,152 19
23 00	....	....	512 38	205 00	....	670 13	4 00	1,790 51
136 00	....	....	....	185 00	....	68 50	....	509 50
40 00	....	....	156 60	160 00	....	....	....	608 10
10 00	....	....	17 31	75 00	....	....	....	215 81
36 50	....	....	80 00	360 00	....	3 00	....	558 00
5 00	....	....	288 75	310 00	....	2 50	....	853 25
763 50	300 00	....	6,502 61	1,520 00	40 00	1,495 10	6 00	15,109 71

TABLE NO. 2—STATEMENT of Fees Collected in the Mining Recorder's Office, Conrad, during the Fiscal Year, 1907-08.

Month.	Q. Grants.	Q. Cert of W.	Q. Cert. of P.	Q. Reg. Doc.	P. in lieu.	Total.
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
April	25 00	5 00	....	....	....	30 00
May	30 00	10 00	7 50	....	....	47 50
June	155 00	47 50	5 00	13 50	100 00	321 00
July	125 00	112 50	22 50	76 00	....	336 00
August	300 00	337 50	12 50	34 50	200 00	884 50
September	155 00	92 50	5 00	2 50	....	255 00
October	25 00	12 50	....	17 50	....	55 00
November	5 00	17 50	....	19 00	....	41 50
December	....	....	....	18 00	....	18 00
January	....	....	....	4 50	100 00	104 50
February	....	20 00	2 50	....	....	22 50
March	....	2 50	....	....	200 00	202 50
Total	820 00	657 50	55 00	185 50	600 00	2,318 00

TABLE NO. 3.—STATEMENT of Fees Collected in the Kluane Office during the Fiscal Year 1907-08.

Month.	Placer.					Quartz.				Total.
	Grants.	Renewals.	Reloc.	Reg. Doc.	C. of W.	Grants.	C. of W.	Reg. Doc.	C. of P.	
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
April	....	720 00	10 00	28 00	....	60 00	....	10 00	....	828 00
May	....	30 00	30 00	....	....	20 00	....	....	....	80 00
June	10 00	690 00	40 00	8 00	2 00	340 00	....	24 50	....	1,114 50
July	....	30 00	....	....	....	70 00	....	....	....	100 00
August	....	105 00	20 00	70 00	....	70 00	....	2 50	12 50	280 00
September	....	330 00	20 00	....	....	40 00	....	....	2 50	392 50
October	....	60 00	20 00	4 00	....	35 00	....	5 00	....	124 00
November	....	75 00	10 00	14 00	....	25 00	70 00	5 00	2 50	201 50
December	....	75 00	....	....	....	....	....	....	2 50	77 50
January	....	....	....	....	....	....	2 50	....	....	2 50
February	....	45 00	10 00	6 00	....	20 00	....	....	....	81 00
March	....	30 00	40 00	7 00	....	....	....	....	....	77 00
Total	10 00	2,190 00	200 00	137 00	2 00	680 00	72 50	47 00	20 00	3,358 50

CORRESPONDENCE AND PAPERS

RELATING TO

SEED GRAIN

IN

SASKATCHEWAN AND ALBERTA

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1908

AN ACT RESPECTING SEED GRAIN.

1908—Chapter 21.

(Assented to February 21, 1908.)

Whereas the Lieutenant Governor in Council has had under consideration the recommendation and report of the Honourable the Minister of Agriculture, which report bears date the sixtd day of February, A.D. 1908, and sets forth that a serious situation exists in the province of Alberta regarding the supply of good seed suitable for next season ; that the condition is due to the weather conditions of last year, the crops not having ripened before the frost; that in many sections of the province the grain on hand is totally unfit for seed; that this is especially true of oats and barley and that prompt attention is necessary to avert possible disaster to the province and Dominion ;

And whereas the said report of the Honourable the Minister of Agriculture further sets forth that the farmers individually cannot successfully cope with the situation, and owing to the money stringency the province cannot depend on the Canadian banks furnishing requisite funds, and there is no time for an immediate foreign loan, the credit of the province not yet being established ;

And whereas the said report of the Honourable the Minister of Agriculture states that the estimated amount of seed needed is one hundred thousand (100,000) bushels of wheat, one hundred thousand (100,000) bushels of barley, and four hundred and fifty thousand (450,000) bushels of oats;

And whereas the said report of the Honourable the Minister of Agriculture recommends that for the purpose of obtaining funds for the purchase of seed grain for the settlers, the provincial treasurer be authorized to receive from the government of Canada, by way of a loan on the credit of the province, the sum of four hundred and forty thousand ($440,000) dollars, or such part thereof as may be required for the purpose stated, and that the province agree to pay the government of Canada any sum so advanced, together with five per centum per annum interest thereon, on or before the thirty-first day of March, 1909, and that if any part of the said sum and interest shall remain unpaid on the said date, the same shall thereupon became a charge upon any subsidy allowance, grant, or money which for any purpose whatsoever may at any time hereafter become payable by the government of Canada to the government of the province of Alberta ;

And whereas the said report of the Honourable the Minister of Agriculture further recommends that the government of Canada may appropriate such portion or portions of any such subsidy allowance, grant, or money as it may deem necessary or advisable towards the repayment of such sum and interest, and that the government of the province engages to recommend to the legislature of the province, at the earliest opportunity, the enactment of a law approving and confirming this order in council;

And whereas it is expedient that the action of the Lieutenant Governor in Council in this regard be ratified by an Act of this province;

Now, therefore, His Majesty, by and with the advice and consent of the Legislative Assembly of the province of Alberta, enacts as follows:

1. It is hereby declared that the Lieutenant Governor in Council shall be deemed to have had power by law to provide by order in council as in the hereinbefore recited order in council provided, and the said order in council is hereby approved, ratified and confirmed.

2. The Lieutenant Governor in Council shall have power and shall be deemed to have had power by order in council to provide for the purchase, sale and distribution among such of the farmers and settlers in the province being owners or occupants of patented land or of land for which the issue of patent has been recommended as apply for the same of the seed grain so purchased in such quantities and upon such terms as to the taking of security for the repayment to the government of the cost of the seed grain so supplied by way of mortgage upon growing crops or otherwise as shall appear necessary or proper.

3. The amount agreed to be paid by any applicant for seed grain in consideration of the advance to him by the government of such seed grain, together with interest thereon at the rate of five per centum per annum until paid, shall be a charge upon any property, real or personal, of the applicant, whether in the province or elsewhere, having priority over all other liens, charges and encumbrances thereon, and being capable of enforcement by seizure and sale of such property upon default in payment of the said amount under a warrant signed by the minister, or by any person authorized by the minister to execute such warrant wherever the said property may be found.

4. The amount agreed to be paid by any applicant for seed grain, together with interest as aforesaid, shall be a tax upon such applicant and upon the land for the cultivation of which seed grain has been furnished, and in addition to any other remedies herein contained or otherwise available for the collection of the same, the following provisions in relation thereto shall have effect:

(*a*) The minister may cause to be furnished to the tax commissioner under The Local Improvement Act, a list of persons to whom seed grain has been supplied, together with the addresses of such persons as given in their application for seed grain, a description of the land in respect of which seed grain has been so supplied, and a statement of the amount agreed to be paid by each of the said persons therefor;

(*b*) Upon the receipt of such list the said tax commissioner shall forthwith send by prepaid post to the persons appearing upon such list at the addresses given therein a notice in form A of the schedule to this Act and thereupon the person to whom such notice is addressed and the land in the said notice mentioned shall be taken to be assessed for the amount mentioned in the notice for taxes due to the province, and such taxes shall be payable on or before the 1st day of March, 1909;

(*c*) In default of the payment of the taxes so due, the said tax commissioner may, by himself or his agent, levy the same with costs by distress upon the goods or chattels of the person who ought to pay the same, or on any goods or chattels in his possession wherever the same may be found, or on any goods or chattels found on the land, the property of or in the possession of any other occupant thereof, and may impound the same on the premises where distrained, and no claim of property, lien or privilege shall be available to prevent the sale or the payment of the taxes and costs out of the proceeds of the sale thereof;

(*d*) Any taxes or arrears of taxes due hereunder may be recovered as a debt by suit in the name of the tax commissioner, and in any such suit proof of the sending of the notice in subclause (*b*) hereof mentioned shall be *prima facie* evidence of the debt;

(*e*) The tax commissioner upon recovering any sum of money for taxes due hereunder shall forthwith forward the same to the Provincial Treasurer.

5. No claim of exemption or privilege whether statutory or otherwise shall be available in any proceedings taken under this Act.

6. Upon notification being received by any person or company from the department that any person is indebted to or has agreed to pay the government the cost of any seed grain supplied to him for his benefit the person or company so notified shall retain out of any moneys that may at any time after the receipt by him of the notice be or become payable to the person to whom, or for his benefit as therein stated seed grain has been so supplied, the amount in the said notice mentioned as the cost of

the seed grain so supplied, or such portion thereof as shall be payable by the person or company receiving the notice to the other, and shall forward the same to the department, and the minister shall thereupon cause a new notice to be sent to the person or company remitting such sum, stating the balance, if any, still due to the government in respect of the seed grain so supplied, and if there be no balance due so stating, and the amount, if any, mentioned in such new notice shall be so retained and remitted as herein provided.

(2) Any person or company omitting to so retain and transmit to the department any such amount as is in this section mentioned shall be liable to pay to the government the amount, if any, which, after the receipt by him of the notice or new notice, he has paid to or on account of the person mentioned in the notice or new notice as the person to whom seed grain has been so supplied, and such amount may be recovered by suit in the name of the minister.

7. The secretaries of small local improvement districts, and the persons occupying the positions of postmaster in large local improvement districts, Dominion land agents, sub-land agents, homestead inspectors and members of the Royal Northwest Mounted Police, shall have the power to administer oaths and to take statutory declarations in connection with applications for seed grain; and all railway station agents shall have power to administer oaths and to take statutory declarations in connection with the securities by way of chattel mortgage or otherwise that may be taken for the cost thereof.

8. The Lieutenant Governor in Council may make such regulations and prescribe such forms, not being inconsistent with this Act, as shall be found necessary or convenient for the proper administration thereof.

9. In this Act, unless the context otherwise requires——

1. 'Department' means Department of Agriculture;

2. 'Government' or 'Government of the Province' means His Majesty in the right of the province of Alberta;

3. 'Land' means lands, tenements and hereditaments, and any estate or interest therein;

4. 'Minister' means the Minister of Agriculture.

SCHEDULE.

Form A.—Notice of Taxes for Seed Grain.

Take notice that you have been assessed in respect of the land herein mentioned the sum of dollars and cents (*amount in figures*) for seed grain supplied to you by the government of Alberta.

And further take notice that the said amount is payable by you to the government of Alberta on or before the first day of March, 1909, and that in default of payment on or before the said date the said amount may be realized by seizure, distress or suit, as provided for in *An Act respecting Seed Grain,* being chapter of the statutes of Alberta, 1908.

The said amount may be paid to the Provincial Treasurer of Alberta, to the Minister of Agriculture thereof, to any one duly authorized by the said minister to receive the same or to the undersigned.

The land in respect of which you are assessed as hereinbefore mentioned is quarter section , township , range , west of meridian.

Dated at the day of 1908.

(Signature of tax commissioner under The Local Improvement Act.)

AN ACT RESPECTING SEED GRAIN.

CHAPTER 8.

(Assented to June 12, 1908.)

His Majesty, by and with the advice and consent of the Legislative Assembly of Saskatchewan, enacts as follows:—

1. The Lieutenant Governor in Council shall have power and snall be deemed to have had power by order in council to provide for the purchase, sale and distribution during the year 1908 among such farmers and settlers in the province as apply for the same of seed grain in such quantities and upon such terms as to the taking of such security for the repayment of the cost of seed grain so supplied as shall appear necessary or proper, provided that the cost of said grain so advanced to any one applicant shall not exceed $250.

2. The Lieutenant Governor in Council shall have power and shall be deemed to have had power to receive from the government of Canada by way of loan on the credit of the province the sum of $1,825,000 or such part thereof as may be required for the purposes stated and to agree to pay the government of Canada any sum so received together with five per centum per annum interest thereon on or before the thirty-first day of March, 1909, and to agree that if any part of the said sum and interest shall remain unpaid on the said date the same shall thereupon become a charge upon any subsidy, allowance, grant or money which for any purpose whatsoever may at any time hereafter become payable by the government of Canada to the province.

3. Any agreement or order in council heretofore made for any of the purposes aforesaid is hereby approved, ratified and confirmed.

4. The amount agreed to be paid by any applicant for seed grain in consideration of the advance to him by the government of such seed grain together with interest thereon at the rate of five per centum per annum until paid shall be a debt due by the applicant to His Majesty and shall be a charge upon any real property of the applicant whether in the province or elsewhere and upon any crop of any kind hereafter grown on any land by the applicant having priority over all other liens, charges or encumbrances thereon whenever created and in addition to any other remedy which His Majesty may have to enforce payment of the said amount; such charge shall be capable of enforcement to seizure and sale of the said real property or crop when growing or when cut under warrant signed by the commissioner of agriculture by any person authorized by him to execute such warrant whenever any of the said property may be found and in respect thereof His Majesty shall have and be entitled to all the remedies of a mortgagee in the same manner as if the said amount were secured by a registered charge against the said land or a chattel mortgage against the said crop and in priority to all taxes, liens, charges and encumbrances thereon.

5. The commissioner of agriculture shall as soon as conveniently may be send to the registrar of land titles for each land registration district a statement showing in alphabetical order the name of each applicant for seed grain as aforesaid and showing the land for the cultivation of which seed grain has been furnished, the amount agreed to be paid by each applicant for seed grain as aforesaid and the date from which interest is payable and if the said land was on such date owned by the applicant or if the said land is shown in the records of the land titles office by caveat or otherwise to be held under an agreement for sale in favour of the applicant, the registrar shall upon receipt of such statement enter in the register against such land and shall indorse the same upon any duplicate certificate of title thereafter issued therefor a memorandum as follows: 'This land is subject to a seed grain lien in favour of His Majesty as represented by the commissioner of agriculture for the province of Saskatchewan for the sum of   dollars and interest thereon at five per centum per annum from the   day of   , 1908'; and in respect of any other land in his land registration district the registrar

shall treat each item in the statement as if it were a writ of execution against the lands of the applicant for seed grain as aforesaid for the amount shown thereby to be owing by the applicant, and may use the form herein provided in making the memorandum required to be made by section 129 of *The Land Titles Act.*

(2) Instead of entering a memorandum in the execution docket the registrar may use a separate docket to be known as the 'Seed Grain Docket.'

(3) The commissioner of agriculture shall also cause the said statement to be published in the Saskatchewan *Gazette.*

6. Any registrar of land titles shall, on receiving a letter signed by the commissioner of agriculture directing him so to do, enter a memorandum in the execution docket or in the seed grain docket as the case may be and upon the certificate or certificates of title in the register to the land of the person mentioned in such letter to the effect that such land and all lands of the applicant as aforesaid are released from the said lien, and thereafter such land shall be absolutely released and discharged from the said lien and from any claim under this Act.

7. Notwithstanding anything contained in *The Bills of Sale Ordinance* or in any other Act or law, every document purporting to be a chattel mortgage heretofore or hereafter given or made to or in favour of His Majesty to secure an advance of seed grain shall be capable of registration free of charge under *The Bills of Sale Ordinance* and shall be valid and effective according to the true intent and meaning thereof, and no irregularity, informality or insufficiency therein or in any affidavit made in connection therewith or the failure to make any such affidavit or the failure to file and register the said document or to file or register the same within the time limited by law for that purpose shall render the same invalid; but every such document shall bind the crop therein mentioned as fully and effectually to all intents and purposes as if all the provisions of *The Bills of Sale Ordinance* and of any other Act or law had been strictly complied with and shall have priority over any other mortgage or lien whenever given upon the security of the same crop or any writ of execution against the mortgagor.

8. To remove doubts it is hereby declared that the Lieutenant Governor in Council had power to make the order in council bearing date the tenth day of February, 1908, empowering such persons in the province as may hold the office of secretary treasurer of a local improvement district or municipality, Dominion land agent, sub-land agent, homestead inspector, immigration agent or member of the Royal Northwest Mounted Police to administer oaths and take and receive affidavits, declarations and affirmations within the province.

CERTIFIED COPY OF A REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL, APPROVED BY HIS EXCELLENCY THE GOVERNOR GENERAL ON THE 17TH MARCH, 1908.

The Honourable the Minister of the Interior.

The Committee of the Privy Council have had under consideration a report, dated March 14, 1908, from the Minister of the Interior, stating that under clause 15 of the regulations, approved by order in council of the 6th February, 1908, respecting the purchase, sale, and distribution of grain to homestead settlers in the provinces of Alberta and Saskatchewan, it is provided that no seed grain shall be supplied to homestead settlers who had sown no crop in the season of 1907. According to the reports received from the officers of the Department of the Interior who have been at work in the west in connection with the distribution, it would appear that the number of applications that are being received for advances of seed grain under the provisions of the regulations is not as large as had been anticipated, and that in consequence the appropriation latetly made by parliament to cover this expenditure is likely to be in excess of the requirements.

The minister recommends, inasmuch as numerous applications have been received from farmers in the provinces of Alberta and Saskatchewan who, although they had sown no crop in 1907, are urgently in need of seed grain during the coming season, and as the machinery for the purchase, distribution and taking of security for advances of seed grain now in operation is well fitted and sufficient to deal with such applications, and as the seed grain needed as above stated is not available in the provinces mentioned, and therefore cannot well be secured by the individual action of those who require it, that clause 15 of the regulations approved by order in council of February 6, 1908, be amended so as to permit of advances to be made to settlers who had sown no crop in the season of 1907, under the same terms and conditions as set forth in such regulations.

The committee submit the same for approval.

(Sgd.) RODOLPHE BOUDREAU,
Clerk of the Privy Council.

MEMORANDUM OF CONFERENCE OF REPRESENTATIVES OF THE DOMINION, SASKATCHEWAN AND ALBERTA GOVERNMENTS.

Dominion government represented by—

W. W. Cory, Esq., Deputy Minister of the Interior.
C. C. Castle, Esq., Purchasing Agent.
R. E. A. Leech, Esq., Inspector Dominion Land Agencies.

Saskatchewan government—

W. R. Motherwell, Esq., Minister of Agriculture.

Alberta government—

George Harcourt, Esq., Deputy Minister of Agriculture.

Regarding the matter of net shortages in out-turn of cars at distributing points.

It is agreed, that actual shortages, which cannot be accounted for, shall be charged up to administration account. The distributing agent shall charge up all shortages to the purchasing agent, giving detailed statement as to out-turns, as verified by statutory declaration by the railway agents and homestead inspectors.

Re the disposal of surplus seed wheat at local points in Saskatchewan and Alberta.

The distributing agent is authorized to send out the following circular to mill owners, and others, asking for quotations, and is authorized to dispose of same. The grain above mentioned will be delivered f.o.b. cars at point of delivery. No quotations will be considered for prices quoted less than track prices at point of delivery; separate quotations must be given for sacks in addition to the price quoted for grain.

Circular 'A.'

'A quantity of seed wheat is left over on the   line of railway after all applications are filled. We are now offering this for sale, which is made up approximately as follows:—

No. 1 H.
No. 1 Nr.
No. 2 Nr.
No. 3 Nr.
No. 4 Wheat.

This grain will be delivered to the purchaser's station on this line, freight free. If you desire to secure this, or any part of it, we would be pleased to have quotations separately for each grade, and also quoting price for sacks. The quantities, as given above, are approximate, and the actual amounts may be more or less. No quotations less than track price, your point, will be considered. Separate quotation must be given for sacks, in addition to the price quoted for grain.'

Re disposal of surplus seed wheat, in hands of the purchasing agent, purchased but not distributed for seed.

That the purchasing agent be authorized to dispose of surplus of wheat now in Winnipeg, Calgary, and Edmonton to the best market advantage, delivery of same to be made and sales to be completed not later than July delivery; the purchasing agent in no case being authorized to sell all or any portion of such purchase at less than the current market price of the grain at date of sale

In the case of the wheat now at Calgary and Edmonton ,the purchasing agent is authorized to dispose of same to local mills, providing he can dispose of same for better price than by shipping the wheat to Fort William for sale there.

Re the disposal of surplus seed oats at local points in Saskatchewan and Alberta.

The distributing agent shall arrange to gather up all surplus seed oats at local railway stations; that in Saskatchewan to be gathered and loaded into car lots and shipped to the order of C. C. Castle, Fort William; that in Alberta to be gathered and loaded in the same way, but to be shipped to the order of C. C. Castle at Edmonton and Calgary, invoicing the same to Mr. Castle according to grades; English, Canadian and Prince Edward Island oats to be kept separate. Prince Edward Island oats to be billed to the order of C. C. Castle, Fort William, stop off at Winnipeg for orders.

That the purchasing agent be authorized to sell the surplus seed oats at Edmonton and Calgary locally in the province of Alberta, at not less than market price, or a premium over the market price; bags extra. If unable to do so, to ship same to Fort William for sale to best market advantage, at or above market prices at Fort William or Port Arthur. The purchasing agent to use his discretion in disposing of these oats at such times, and in such quantities, as it may be most advantageous, so as to realize the highest market price possible. In the event of the oats being shipped to Fort William or Port Arthur the grain to be unloaded into the grain elevators there and the sacks turned over to the inspector for the account of the seed grain purchasing agent. The sacks, subsequently, to be sold to the best market advantage.

Re the disposal of surplus seed barley at local points in Saskatchewan and Alberta.

In the event of there being any surplus barley left, after applications have been filled, the same will be gathered up and shipped to the order of C. C. Castle, Fort William, to stop over at Winnipeg for instructions.

Re the disposition of grain sacks on hand after deliveries are completed.

The purchasing agent is authorized to make sale of the same to the best advantage, using his own discretion as to time and place for making sales.

Re thirteen cars of oats and two cars of wheat, purchased by the Alberta Government from Mr. Castle, Purchasing Agent.

It is agreed that this grain shall be treated as having been handled under the ordinary distribution arrangements; that is, applications and mortgages shall be completed in proper form by the representative of the Alberta government, and transferred to R. E. A. Leech, distributing agent. The invoices which have been sent to Mr. Harcourt shall be transferred to Mr. Leech and Mr. Leech shall issue formal requisition upon Mr. Castle to cover the invoices. If, however, in connection with this transaction there have been extra freight charges, amounting to more than $1,000, the Alberta government shall pay such amount as is in excess of $1,000.

Re Office furniture purchased for the Seed Grain Offices in Regina.

If the furniture has not already been paid for by Mr. C. H. Beddoe, from the seed grain appropriation, he shall arrange to make such payment. If the Dominion Department of Public Works has paid for the furniture Mr. Beddoe shall arrange to reimburse the Department of Public Works, by paying for same out of the seed grain appropriation. When the offices are closed the distributing agent shall dispose of the same to the best advantage.

In connection with the furniture in the Winnipeg offices, Mr. Castle shall dispose of this to the best advantage.

Dated at Regina, May 18, 1908.

W. W. CORY,
GEO. HARCOURT,
W. R. MOTHERWELL.

REPORT OF THE PURCHASING AGENT.

WINNIPEG, MAN., June 26, 1908.

The Hon. FRANK OLIVER, M.P.,
Minister of the Interior,
Ottawa, Ont.

SIR,—Acting under the instructions of the Right Honourable the Minister of Trade and Commerce as contained in the following telegram :—

Ottawa, Ont., January 15, 1908, to C. C. Castle, Winnipeg, Man. 'Arrange to accompany Mr. Motherwell to Ottawa in connection with the seed grain relief problem,' signed F. C. T. O'Hara, Acting Deputy Minister.

I proceeded to Ottawa with the Honourable W. R. Motherwell and the Honourable J. A. Calder, Commissioner of Agriculture and Finance Minister, respectively, of the province of Saskatchewan. Upon arrival at Ottawa I reported to the minister, who instructed me to place my services at the disposal of the Minister of the Interior and the representatives of the provinces of Saskatchewan and Alberta, then assembled at Ottawa, in connection with the seed grain advance problem.

Daily conferences were held in regard to this matter between the federal and provincial authorities (at which I was present under instructions) resulting in an agreement being reached between the governments concerned, under which I was appointed as grain purchasing agent.

In pursuance of the duties assigned to me under the aforesaid agreement, I received instructions from the Right Honourable the Minister of Trade and Commerce to act under the instructions of the Honourable the Minister of the Interior in the matter of purchasing seed grain, as per attached copy, file No. 10347, Department of Trade and Commerce, Ottawa, Canada.

C. C. Castle, Esq.,
Warehouse Commissioner,
Winnipeg, Man.

Re Seed Grain Relief.

Sir,—I am directed by the Right Honourable the Minister of Trade and Commerce to instruct you to act under instructions of the Right Honourable the Minister of the Interior in the matter of purchasing seed grain. I have also to state that Mr. Horn is being communicated with to act with you in the matter of inspecting this seed grain.

I have the honour to be, sir, your obedient servant,

(Sgd.) F. C. T. O'HARA,
Acting Deputy Minister.

Official notification of my appointment as Seed Grain Purchasing Agent was conveyed to me by letter signed jointly by the Minister of the Interior and the representatives of the Saskatchewan and Alberta governments, as follows:—

Interior Department,
Ottawa, Canada, January 31, 1908.

Charles C. Castle, Esq.,
Warehouse Commissioner,
Winnipeg, Man.

Sir,—In consequence of an arrangement having been entered into between the Dominion government and the governments of the provinces of Saskatchewan and Alberta, whereby certain quantities of wheat, oats and barley shall be purchased by the government and supplied to certain farmers in these provinces who have no seed fit to sow this season and are without the necessary means to procure same, you have been appointed by the government to make purchases of grain for this purpose.

In the purchase of said grain the following conditions are to be observed:—

The wheat shall be bought through the ordinary channels of the grain trade at current prices from day to day, subject to official grade and weight by the proper officers of the grain inspection and weighing branches of the Department of Trade and Commerce; that grades 1 and 2 Northern only shall be purchased if sufficient of these grades can be procured, but if not, No. 3 Northern may be purchased from receiving elevators or in transit at Winnipeg, but not in terminal elevators; that grade No. 4 wheat may, if necessary, be purchased wherever it can be procured, having due regard to its suitability for seed purposes, its grading and cleanliness, but should be purchased only in the event of there not being sufficient of the other grades procurable.

That oats shall be purchased by you through the ordinary channels of the grain trade at western receiving elevators, at Winnipeg in transit to Fort William, or at Fort William; and shall be of grades Nos. 1, 2 and 3 White Oats as inspected and weighed by the Dominion grain inspection and weighing officials; provided, however, should such purchases be made subject to the test as to vitality a fixed advance on the market price from day to day may be arranged for by you at your discretion.

It is agreed that all purchases of grain in Canada shall be made by you, and that purchases outside of Canada shall be made by you as may be practicable under advice of G. H. Clark, Seed Commissioner, Department of Agriculture.

All points dealing with the matter of purchase and transportation of seed grain not herein provided for shall be at your discretion, assisted in all matters of inspection and cleaning by David Horn and G. H. Clark, and further assisted by way of consultation wherever practicable by the heads of the Department of Agriculture of the provinces of Saskatchewan and Alberta.

The barley required to be purchased may be bought in eastern Canada, Fort William or the West in your discretion and shall be of the grades No. 2, 3 extra and 3.

That where practicable grain may be purchased in car lots direct from farmers in Manitoba, Saskatchewan and Alberta at current prices from day to day, subject to official grade and weight.

You are hereby authorized to at once purchase 800,000 bushels of wheat in accordance with the above instructions, 1,500,000 bushels of oats and 300,000 bushels of barley.

That every precaution shall be taken to have all seed purchased free from smut, noxious weeds and other varieties of grains, and with this object in view all such grain shall, if found necessary, be recleaned as thoroughly as possible at such warehouse cleaning plants as can be secured for this purpose.

That cleaning and recleaning shall be done under the responsibility and supervision of David Horn, Chief Grain Inspector, Department of Trade and Commerce, and that officers shall be appointed by the Ministers of Agriculture for the provinces of Alberta and Saskatchewan to render all possible assistance to the chief inspector, and such officers shall consult with him upon all matters relating to the recleaning of grain.

That the seed testing branch of the Dominion Department of Agriculture shall make such provision for the testing of all seed grain purchased in the West or elsewhere as may be found necessary and practicable.

That all grain shall be sacked after recleaning according to its grade by inspection on receipt into store and that each sack shall be distinctly marked with the kind and grade of the grain contained therein, and that all sacks shall be sewn, not tied.

That all grain purchased by yourself shall be cleaned and stored according to its inspected grade in a cleaning elevator at such point or points as you may determine at such rate or rates for storage, insurance, &c., as you may agree to with the owner or owners of such cleaning elevator, and that such stored grain shall be held subject to your order for shipment in sacks after recleaning; provided, however, that the Minister of the Interior shall appoint an officer to receive delivery ex elevator of such sacked grain into cars, whose notification in writing to you shall be your authority to deliver such grain.

You are hereby authorized to purchase whatever number of sacks may be necessary for the sacking of all grain purchased by the government in connection with the scheme of seed grain relief; for settlement of freight, weighing, insurance, inspection and other charges and all other transactions in rgard to grain until you shall have made delivery of same as above provided.

You shall before any seed is distributed furnish the person in charge of the Central Distributing Office with a statement of the estimated average cost of each class and grade of all grain to be advanced, and such average cost shall include the price paid for grain, cost of cleaning, storage, commission, premium, insurance, sacking, freight, and all other lawful charges; and in estimating such cost you shall take into account the shrinkage or loss arising from cleaning or otherwise and the proceeds of all screenings or cleanings which you are hereby authorized to dispose of to the best advantage. In the case of oats imported from Europe and barley from Eastern Canada the actual cost thereof, including price paid, cost of sacking, freight, &c., shall be charged, but exclusive of the cost of administration.

That matters relating to the purchase and transportation of seed grain not herein provided for shall be at your discretion, assisted in all matters of inspection and cleaning by David Horn, and in the matter of testing for vitality by G. H. Clark, and further assisted by way of consultation wherever practicable by the heads of the Department of Agriculture of the provinces of Saskatchewan and Alberta or officers appointed by them for the purpose.

On receipt of order from chief distributing officer to ship to point of distribution you will load and consign as therein directed and will forward to such officer a statement showing the number of bags, grade and kind of grain loaded into each car, with the initial letter, car number and date of loading ex elevator and destination. On such car being unloaded the chief distributing officer shall take a receipt from the person responsible for the unloading, showing the initial letter, car number, bags, grade, and kind of grain, also stating condition, and shall cause a copy to be forwarded to you.

Cancellation of insurance in grain to be made at your discretion as soon as the loaded cars are lifted by the railway company from the elevator siding.

All sacked grain to be shipped in car lots except under special instructions in writing from the officer above referred to.

As it has been arranged that all grain shall be recleaned if necessary before being sacked and distributed to farmers, the cleanings are to be sold by you to the best market advantage, and proper account of same entered in your records with the price received therefor, &c.

All money received from such sales shall be deposited at the bank to the special seed grain account.

There will, of course, be a shrinkage or loss in recleaning the grain which will be absolutely lost, such as weed seeds, straw chaff, dust, &c., and in the preparation of your balance sheets the actual waste which has been cleaned out and sold must be shown and any shrinkage or loss in weight as above referred to actually ascertained must also be correctly shown.

In any event of its being deemed desirable to receive any grain at outside points such as Regina, Calgary, Moosejaw and elsewhere, you are authorized to make the necessary arrangements for the receiving, handling and recleaning of whatever grain may be necessary at a receiving elevator at any such point, and fix a price to be paid the owner of such building for the work of handling, receiving, cleaning, recleaning, storing, sacking, sewing, branding, weighing and delivering such grain into cars, which arrangement is also applicable at Winnipeg or St. Boniface.

The following trades already reported by you as having been made on the 29th of January are hereby approved:—

5,000	May option	$1 13½
15,000	"	1 13⅝
30,000	"	1 13
50,000	"	1 13
25,000	February option	1 09

You are no doubt aware I have made arrangements with Mr. Wm. Whyte, second vice-president of the Canadian Pacific Railway, and also with the other railway companies' head offices for special rate on this seed grain. Nothing, however, has yet been definitely fixed, but you will be able to complete arrangements on your return to Winnipeg.

Yours very truly,

(Sgd.) FRANK OLIVER,
Minister of the Interior.

Approved, J. A. Calder, Sask.
Geo. Harcourt, Alberta.

The further additional instructions were received from the Honourable the Minister of the Interior under dates the 1st and 4th of February, as follows:—

OTTAWA, February 1, 1908.

Mr. C. C. CASTLE.

As payments to be made in connection with the purchase of grain will have to be made at the time of purchase, it will be necessary for you to consult the Department of Finance as to the best method of arranging the matter. All payments relating to the administration will be made by cheques issued at Ottawa, after estimates have been made and recommended for payment.

It is understood that you have authority to rent a suitable office temporarily and to secure the services of an expert grain accountant and also any clerical assistance which may be required to conduct the business connected with the purchase, cleaning, sacking, etc., of the grain, and you are authorized to rent for the time being furniture requisite for yourself and staff. If you should find it necessary to have a telephone you are at liberty to have one placed in your office, and in regard to the proposed purchase of a wide carriage tabulating typewriter, I think it would be better to rent one, especially in view of the fact that it will be required only for a few months.

If either Mr. Gelley of the Immigration Agency at Winnipeg, or Mr. Stephenson, of the Dominion Lands Office, have a stenographer and typewriter competent to do the work you require, it would be well to arrange with them if possible for the temporary assistance you will need.'

(Sgd) FRANK OLIVER,
Minister of the Interior.

And under date February 10, 1908, the Honourable the Minister of the Interior wrote inclosing me a copy of an order of His Excellency the Governor General in Council approving of the regulations respecting the purchase, sale and distribution of seed grain, the duties of the purchasing agent being prescribed in the first fourteen clauses thereof. I therefore attach hereto copy of said clauses:—

AT THE GOVERNMENT HOUSE AT OTTAWA.

THURSDAY, 6th day of February, 1908.

PRESENT:—His Excellency the Governor General in Council.

His Excellency the Governor General in Council is pleased to approve, and doth hereby approve, of the following regulations respecting the purchase, sale and distribution of seed grain to homestead settlers in the provinces of Alberta and Saskatchewan which have been made by the Minister of the Interior in pursuance of the order in council of January 30, 1908, respecting the distribution of seed grain to settlers.

Regulations respecting the purchase, sale and distribution of seed grain to homestead settlers in the provinces of Alberta and Saskatchewan:—

1. All purchases of grain in Canada shall be made by the warehouse commissioner of the Department of Trade and Commerce, C. C. Castle, hereinafter called 'the purchasing agent,' and all purchases outside of Canada shall be made by the purchasing agent under the advice, when it is practicable to obtain the same, of the seed commissioner of the Department of Agriculture, G. H. Clark.

2. Wheat shall be bought through the ordinary channels of the grain trade at current prices, from day to day at western receiving elevators, at Winnipeg, in transit to Fort William or elsewhere, subject to official grade and weight by proper officers of the grain inspection and weighing branch of the Department of Trade and Commerce. Grades 1 and 2 Northern only shall be purchased if sufficient of these grades can be procured, but, if not, No. 3 Northern may be purchased from receiving elevators or in transit at Winnipeg, but not in terminal elevators. Grade No. 4 wheat may, if necessary, be purchased wherever it can be purchased, having due regard to its suitability for seed purposes, its grading and cleanliness, but should only be purchased in the event of there not being sufficient of the other grades procurable.

3. Oats shall be purchased through the ordinary channels of the grain trade at western receiving elevators, at Winnipeg, in transit to Fort William, at Fort William or elsewhere including eastern Canada, and shall be of grades Nos. 1, 2 and 3 White oats, as inspected and weighed by the Dominion grain inspection and weighing officials, provided, however, should such purchases be made subject to a test as to vitality, a fixed advance on the market price from day to day be arranged for by the purchasing agent at his discretion.

4. Barley shall be purchased as in the case of oats and wheat, and may also be purchased in eastern Canada, and shall be of grades Nos. 2, extra and 3.

5. Where practicable grain may be purchased in car lots direct from farmers in Manitoba, Saskatchewan and Alberta at current prices from day to day, subject to official grade and weight.

6. All possible precaution shall be taken to have all seed purchased free from smut, noxious weed seeds and other varieties of grain, and with this object in view all such grain shall, if found necessary, be recleaned as thoroughly as possible at such warehouse cleaning plant as can be secured for this purpose.

7. Inspection, cleaning and recleaning shall be done under the direction of the purchasing agent by the grain inspector of the Department of Trade and Commerce, David Horn, assisted by such officers as may be appointed for the purpose by the governments of the provinces of Alberta and Saskatchewan respectively.

8. The seed testing branch of the Dominion Department of Agriculture, under the direction of the seed commissioner, assisted by such officers as may be appointed for the purpose by the governments of the provinces of Alberta and Saskatchewan respectively, shall make tests for the purpose of ascertaining the vitality of all seed grain purchased in the west or elsewhere, whenever the same may in the judgment of the seed commissioner be necessary and practicable.

9. All grain shall be sacked after recleaning according to its grade by inspection on receipt into store, and each sack shall be distinctly marked with the kind and grade of the grain contained therein, and all such sacks shall be sewn.

10. All grain purchased by the purchasing agent shall, if necessary, be cleaned, and if stored shall be stored according to its inspected grade in a cleaning elevator at such point or points as he may determine, at such rate or rates for storage, insurance, &c., as the purchasing agent may agreewith the owner or owners of such cleaning elevator; and all grain shall be shipped for delivery by the purchasing agent on the order of the officer in charge of the central distributing office at Regina hereinafter mentioned.

11. The purchasing agent shall purchase and provide the necessary sacks; arrange freight charges subject to any agreement as to freight rates made by the minister with the railway companies; certify to weighing and inspection charges, and make all other necessary arrangements for shipment and delivery of the grain as provided in the next preceding clause of these regulations.

12. A homestead settler or homesteader in these regulations shall mean a person occupying under a homestead entry, and who has not received a recommendation for a patent. The price charged for seed grain to homestead settlers shall be the estimated average cost thereof at the point of delivery, such cost to include storage, commission, premium, insurance, sacking, freight and all other proper charges, but not the cost of administration necessary in connection with the matters herein provided for, and in the case of oats imported and oats and barley brought from Eastern Canada said settlers shall be charged the actual cost therof including price paid, cost of sacking, freight, cost of cleaning, storage, commission, insurance, and all other proper charges exclusive of the said cost of administration.

13. The purchasing agent shall, before any seed is distributed, furnish the officer in charge of the central distribution office at Regina with a statement of the estimated average cost or actual cost as provided in the next preceding clause of each class and grade of grain to be supplied, and such average cost shall include the price paid for grain, the cost of cleaning, storage, commission, premium, insurance, sacking, freight and all other proper charges, and in arriving at such average and actual cost, respectively, the purchasing agent shall take into account the shrinkage or loss arising from cleaning or otherwise, and the proceeds of all screenings or cleanings which he is hereby authorized to dispose of to the best advantage.

14. All matters relating to the purchase and transportation of seed grain not herein provided shall be in the discretion of the purchasing agent.

I arrived here from Ottawa on February 5, and at once secured an office adjacent to the Grain Exchange; and with the assistance of a grain expert formulated a system of books for the proper keeping of accounts, and later on engaged an office staff.

Advertisements were placed in all the leading newspapers in the Northwest stating I had been appointed purchasing agent, &c. Copies of these advertisements are hereto attached, marked exhibit 'A and B.'

While the forms of books, &c., were being printed I entered into negotiations with all elevator owners in Winnipeg and other points with a view to making arrangements with them to clean all seed grain purchased by the government.

Cleaning contracts were subsequently entered into with the following firms:—

1. C. P. R., Fort William.
2. Ogilvie Flour Mills Co., Winnipeg.
3. Anchor Elevator Co., Winnipeg.
4. Canada Malting Co., Winnipeg.
5. Crown Elevator Co., St. Boniface.
6. Western Canada Flour Mills Co., St. Boniface.
7. International Elevator Co., St. Boniface.
8. E. A. McKenzie & Co., Brandon.
9. Winnipeg Elevator Co., Regina.
10. D. McLean & Co., Moosejaw.
11. Calgary Malting Co., Calgary.
12. Brackman-Ker Milling Co., Calgary.
13. Western Milling Co., Calgary.
14. Brackman-Ker Milling Co., Strathcona.
15. Alberta Grain Co., Edmonton.

The rate for receiving, handling, cleaning, sacking and delivering cleaned sacked grain to cars was three cents per bushel; except in the case of the English oats, which were cleaned at Fort William by Canadian Pacific Railway, which they agreed to handle at 2½ cents per bushel.

Under the letter of 31st of January above referred to I was instructed to purchase 800,000 bushels of wheat, 1,500,000 bushels oats and 300,000 bushels barley, and as all this quantity of grain had to be sacked before being distributed I therefore made contracts with two local and three eastern bag manufacturers for the necessary supply.

Particulars of sack contracts are given under exhibit 'C.'

Sack contracts were let on the 11th of February, and the first supplies were forwarded to cleaning elevators on the 17th of February.

Shortly after my return from Ottawa the press published a statement to the effect that the government intended purchasing for seed 1,300,000 bushels of wheat, 1,650,000 bushels of oats and 300,000 bushels of barley, on account of which, sellers materially stiffened their prices (farmers as well as dealers), and it very soon became apparent that I should have to pay May price at least in order to secure the amount of wheat required for seed in proper time. In the meantime I had been endeavouring to secure it at the current cash price, but without effect. I therefore entered into negotiations with the large elevator companies with a view to seeing if purchases of at least 400,000 bushels of contract wheat could not be supplied by them at current prices, but found that all their contract grades had been already sold for May delivery. They offered to purchase back stated quantities of their May sales, and sell such amounts to me, provided I paid the same price as they had to give on such re-purchases. Eventually I agreed to this plan.

By this plan I did not require to personally go on the open market to purchase May wheat; the dealer had to do this under my instructions. For example, on the 13th of February I made contracts under above arrangement for 290,000 bushels of May wheat and started paying in the morning $1.11, every subsequent purchase being fractionally lower until $1.08¾ was reached, proving purchases were very judiciously made, as had it been known I was on the market prices would have advanced probably several cents per bushel.

As it was deemed advisable to purchase all grain required for seed west of Winnipeg, if possible, arrangements were made with the railroad companies to stop off for twenty-four hours, all cars noted by inspectors as suitable for seed. Eventually all cars of the desired grade were stopped here, and the time of stop off increased from twenty-four to thirty-six hours.

Before taking delivery of any grain for seed purposes I arranged with Mr. E. D. Eddy, an officer of the Seed Commissioner's Department, and who was acting under instructions of Mr. G. H. Clark, Ottawa, to examine for purity official samples of all cars inspected at Winnipeg, and to mark his acceptance or rejection on same.

Up to the 17th of February Mr. Eddy had examined a large number of cars, but very few were accepted by him as suitable for seed, as at that time he refused to accept any grain that could not be cleaned to conform to the Seed Control Act, viz.: 1 noxious weed per lb.

On account of the large proportion of cars that were so refused the dealers above referred to who had sold their May wheat, stated they would be unable to fill their contracts (I had a clause in the contract giving me the privilege of rejecting any cars rejected by the inspectors as unsuitable for seed). One dealer during a few days had thirty-six cars of 1° and 2° rejected for seed purposes, and other dealers like proportions, which resulted in a deadlock. The dealers then refused to ship out any more grain under conditions that it would only be passed subject to the provisions of the Seed Control Act. About this time, however, the Honourable W. R. Motherwell, Commissioner of Agriculture, Regina, Saskatchewan, at my urgent request came to Winnipeg for a conference on this matter; as a result of which it was eventually agreed that the standard of inspection for wheat should allow not more than 10 wild oats or 10 purple cockle per pound; in addition samples that contained small weed seeds easily removable by cleaning were not to be rejected.

As regards the standard for oats: For a time the same impurities as in wheat were allowed—later this was raised to 15 and finally 25 wild oats per lb. had to be the maximum standard of impurities permitted, otherwise I question whether 75,000 bushels would have been obtained.

At my urgent request Mr. G. H. Clark came to Winnipeg, arriving here on Monday, February 24, and the day following the Hon. W. R. Motherwell arrived. A conference was held at which these two gentlemen and Mr. David Horn (Chief Grain Inspector) were present, which resulted in the following memorandum being drawn up for my guidance:—

WINNIPEG, February 25, 1908.

Memo. for CHAS. C. CASTLE,
Seed Grain Purchasing Agent,
Winnipeg.

It would appear from the character of the supplies of seed grain offered up to date that if quality and purity of the seed is to be given proper and due consideration, then the price paid therefor must be quite secondary, and further, if the seed grain that appears to be required is to be obtained in seasonable time the supplies from the interior must come forward more rapidly than at present; or it will be advisable to go to Fort William for a considerable portion of the wheat required.

In view of the foregoing, advice is given you as follows :—

Memo. of recommendation *re* procuring supplies of seed grain that may be acceptable to the farmers of the provinces of Saskatchewan and Alberta.

1. Make quality especially in respect to weed seeds the first consideration. The matter of price within reason for good clean seed grain should be of secondary consideration.

2. For seed grain, not the product of the western provinces and which has not

now been accepted, adhere in the meantime to the provisions of the seed controller in respect to purity.

3. For wheat, the product of the western provinces allow not more than 10 noxious weed seeds per lb., then reclean. Pay sufficient extra premium for what will pass Seed Act.

4. For oats, the product of the western provinces, allow not more than 25 noxious weed seeds per pound, and then reclean. Pay small premium when they contain 10 wild oats or other noxious weed seeds per pound, and large and sufficient premium for oats that will pass Seed Act and is otherwise good seed.

5. Many portions of the province of Saskatchewan grow oats only for feed, and in view of the probable shortage of clean white oats, you are advised to purchase up to a quarter of a million of bushels of Prince Edward Island black oats for the province of Saskatchewan.

6. Procure, say, five cars of oats, out of several of the best bins at Fort William and have them sent to King's elevator to test result of his cleaning up to loss of 15 per cent.

7. Arrange, practicable and expedient, with the Canada Malting Company for the purchase of seed barley on commission, or otherwise, as may be in your best judgment, subject to the conditions in respect to wheat seeds as obtains for seed oats.

8. Suggest placing orders for Ontario and other eastern Canada oats and barley on commission basis with eastern Canada seedsmen, such as Steele-Briggs Seed Company. Allow sufficient commission to induce prompt and agressive action and allow good premiums per bushel in advance over Toronto or other current market quotations for commercial grain—oats and barley cleaned for seed.

9. Restrict further British orders to named varieties and prevent as far as possible importations of potato oats. Pay good premium for right good seed for Britain.

10. It is recognized that by continuing to adhere to this relatively high standard of purity, all of the demands for seed grain may not be supplied, but it is thought expedient at this time, that especially in view of past charges on the part of farmers in general. against government importations of seed grain containing weed seeds to purchase only and all that it is possible to get for them of relatively clean seed wheat, oats and barley.

Acting in an advisory capacity, we hereby attach our signatures.

(Sgd.) GEO. H. CLARK.
(Sgd.) W. R. MOTHERWELL.
(Sgd.) DAVID HORN.

The provisions of second part of clause 4 were not acted upon, nor were those in clause 5, owing to it being evident that upwards of 500,000 bushels of excellent seed oats could be obtained in Great Birtain without disturbing the market price there.

As regards clause 6, one car of 2 white oats was sent from Canadian Pacific Railway elevators at Fort William to King's for special treatment. This car contained 1 per cent of wild oats, but after repeated cleaning and a loss in weight of 20 per cent, it still contained a half of one per cent of wild oats, thus demonstrating that the Fort William oats with that percentage of wild oats were quite unfit for seed purposes, even after most severe recleaning.

As up to February 25 only 130 cars of wheat and 27 cars of oats had been accepted as suitable for seed, it was decided, after a further conference with the Hon. W. R. Motherwell, Messrs. Horn, Clark and myself that a system of premiums should be inaugurated with the object of securing the very purest qualities of grain possible and inducing prompter and heavier shipments being immediately made. This plan worked out as anticipated (upwards of 40 cars a day being inspected and accepted as suitable for seed, against twelve to fourteen before the plan was adopted), and on March 18 I practically discontinued buying, merely taking delivery of purchases previously contracted for.

Prior to this, fearing I might not be able to get sufficient supplies of seed west of Winnipeg, I had samples drawn by the inspectors at Fort William and Port Arthur from all bins in terminal elevators at these points of the grades 1° and 2° wheat, 1 and 2 white oats and No. 3 barley, which upon examination by Mr. E. D. Eddy here gave results averaging from 1 to 3 per cent of wild oats. With such results I determined not to buy a bushel of seed grain at the lake front if I could avoid it, and it was after bringing this matter to Mr. Motherwell's notice that the premium system as regards wheat bought west of Winnipeg was inaugurated. The oats and barley showed equally bad results, so that as west of Winnipeg the supplies were limited, it was obvious seed oats and barley would require to be imported.

Importations of seed oats were made from Prince Edward Island, also from Great Britain. About 100,000 from the former and some 400,000 from the latter. The Prince Edward Island oats upon inspection at Pictou were so soft that I refused acceptance until the shippers guaranteed them against heating in transit to Winnipeg. A satisfactory banker's guarantee was given before any of these oats were paid for. However, they arrived here apparently in as good order as when inspected at Pictou—but were still quite damp—but upon being unloaded and run over the cleaners twice this defect was partly removed.

At the very beginning when it was estimated that 1,650,000 bushels of seed oats would have to be furnished by the government and at the same time it was estimated that only about 300,000 bushels of suitable seed was available west of Winnipeg it was agreed by the representatives of the federal and provincial governments that seed oats would have to be imported either from Great Britain or the States, or both. After most careful inquiries it was found that possibly 250,000 bushels could be secured from the States and possibly the same quantity from Great Britain. Valuable information concerning importations from the States was secured by Mr. G. H. Clark, seed commissioner of the Department of Agriculture, Ottawa, who at your request made a special trip for the purpose to Chicago, Duluth, Minneapolis and St. Paul. While as regards British importations valuable information was first secured through the Right Hon. Lord Strathcona, the Canadian High Commissioner at London, to whom you had communicated upon the matter by cable.

After the most careful consideration I concluded that the British oats were infinitely better than any that could be secured in the States and could be laid down at Winnipeg for less money.

I, therefore, in the first instance placed orders in the hands of Jas. Richardson & Sons, Kingston, Ont., for 131,000 bushels, under the following conditions : The conditions of purchase being 'No. 1 white milling oats, only named variety, weighing from 40 to 42 lbs. per imperial bushel, sound, suitable for seed, free from noxious weed seeds and wild oats at 66 cents per bushel of 34 lbs. sacked f.o.b. cars St. Johns, plus actual freight to Winnipeg. Any dispute as to quality and freedom from noxious weed seeds and wild oats to be decided by David Horn, Chief Grain Inspector, Winnipeg, whose decision shall be final and binding on both parties.'

Later the order under your insructions was increased to half a million bushels, and at your suggestion the Hon. the Minister of Agriculture instructed Mr. A. W. Grindley, chief cargo inspector of the Canadian Department of Agriculture at Liverpool, to make arrangements for the inspection of the grain before being loaded on vessels at London, Liverpool, Glasgow, or other British port. This arrangement was subsequently carried into effect and the following draft of cablegram was wired me on the 14th of February for amendment or approval : —

'Following draft of telegram prepared to be sent Strathcona. Please consider and amend or approve by wire to me. Dominion, London-Matter purchase seed oats from Britain responsibility of inspection and issue certificate on kinds and quality ordered vested in Department of Agriculture, Department Interior through Charles C. Castle, Winnipeg, purpose placing orders with commission dealers subject inspection British ports. Castle will instruct *re* kinds and quality standard. Minister wishes you place inspection in hands A. W. Grindley who should procure services one suitable referee grain man and one expert seedsman to inspect and pass upon all shipments from Great Britain. (Sgd.) Agricult.

'(Sgd.) F. OLIVER.'

Upon receipt of my approval by wire, the above cablegram was sent to Lord Strathcona, London, who subsequently sent for Mr. Grindley and arranged for him to issue certificates as to quality and freedom from noxious weed seeds and wild oats. Subsequently Mr. Grindley arranged with the London and Liverpool Corn Trade Associations to issue certificates showing the natural weight per bushel of the various shipments. Mr. James Charnock of the firm of Messrs. Jos. Pyke & Son, was appointed upon recommendation of the Liverpool Corn Association, Limited, to inspect shipments from Liverpool and Glasgow, and Mr. W. B. McMaster was appointed upon recommendation of the London Corn Trade Association to inspect the London shipments as to grade and purity.

Certificates as to quality, &c., and weight were attached to all cargo bills of lading from Great Britain. In some cases the certificates issued by the British inspectors were not definite, and while they showed that the oats did not strictly comply with the terms of contract, they did not state the number of foreign seeds per pound contained in sample—in some cases, however, it was stated on certificate that the impurities could easily be cleaned out. Shippers, however, were notified by Mr. Grindley that these lots if shipped would have to go at their risk. The whole of the cargo containing these lots I had re-inspected on arrival here; most of them were 'line samples,' and complied so closely to the Seed Control Act that I passed them, as the impurities were easily removed upon running over the cleaners—a process all seed grain was submitted to. Some of the certificates clearly showed that parts of certain cargoes contained too many wild oats to comply with the terms of contract—even after being cleaned. These lots were also re-inspected upon arrival here, and I found I had to reject some 20,000 bushels, chiefly on account of the percentage of wild oats they contained.

The quality of the imported British oats is the finest I have ever seen, some samples weighing from 46 to 48 lbs. per bushel, and I desire to express my appreciation of the service to Canada performed by James Richardson & Sons, the people that purchased them, because it is surely a service to the country that the farmers of the Northwest should have had placed at their disposal seed of such excellence. The varieties imported were the Abundance, Banner and No. 1 White English; also about 3,000 bushels of Regenerated Abundance were purchased from Gartons, Limited, at the request of the Saskatchewan and Alberta governments; these weighed 51 pounds per imperial bushel, and were absolutely pure pedigree stock.

A small quantity of oats were also brought in from Ontario, Steele, Briggs & Co., Toronto, supplying the bulk of it—of very choice Ontario seed. All of this seed was inspected in Ontario by official grain inspectors and by Seed Commissioner Clark's expert as to purity.

Owing to Manitoba barley showing so much frost and also containing such proportions of wild oats, all barley purchased was brought in from Ontario and was of an excellent quality. I was, however ,only able to secure about one half of what was required. The shortage was made up by shipping in lieu thereof imported English oats, which arrangement was made with Mr. R. E. A. Leech's concurrence.

All of the barley brought in from Ontario was officially inspected in Ontario as to grade, and as to purity by Seed Commissioner Clark's expert.

Wheat.—All wheat for seed purposes was purchased west of Winnipeg, basis May price, store Fort William, date the car was inspected. After the beginning of March a certain set of premiums (see Schedule B) was paid in addition thereto.

Oats.—In addition to those imported local oats were bought at the commencement at current market cost prices, basis store Fort William, which were later on raised to a flat rate of 65c. per bushel, store Fort William. I found in numbers of cases farmers were selling seed oats to neighbours at 70c. and upwards per bushel, consequently I had to raise the price or not get any.

Barley.—All barley for seed was purchased in Ontario, and was bought as high as $1.05 cleaned and sacked f.o.b. cars Winnipeg. Other lots were bought at 75 and 80 cents at Ontario points and cleaned and sacked at Winnipeg afterwards.

Cleaning operations were carried on at Fort William, Winnipeg, Brandon, Regina, Moosejaw, Calgary, Strathcona and Edmonton. A representative of either the Saskatchewan or Alberta governments was in charge practically in each cleaning elevator at above points. This official had power to order all grain to be run over the cleaners until he was thoroughly satisfied it was clean enough for seed. Every car received at such elevators was run two or more times over the cleaners, some cars being run through five times. Under my contract with the elevator owner the provincial government's representative had authority to order any or every car cleaned as often as he desired, before he allowed the grain to be sacked.

The method of handling the grain was as follows:—

While I was on the market to purchase seed grain the railroad companies issued instructions for all cars suitable for seed to be held out at Winnipeg for twenty-four hours; subsequently this period was extended to thirty-six hours. Public announcements were made both by the railroad company and by myself to that effect.

As soon as official samples of the inspected cars were received at the chief inspector's office they were turned over to Mr. E. D. Eddy (of the seed commissioner's office, Ottawa), who with his assistants made a most careful analysis of same. After this Mr. Eddy issued a certificate stating thereon the number of impurities per pound contained in sample. If it was suitable for seed the certificate, in addition to the foregoing, was marked 'O.K.'—or otherwise if it was marked 'rejected.' All certificates were made out in duplicate and signed by Mr. Eddy or his deputy.

A list of all cars examined by Mr. Eddy was made out and forwarded to my office twice daily (see Exhibit 'Selection sheet'), on which those accepted were marked 'O.K.,' and those not accepted were marked 'Rejected,' and attached to this sheet was the original seed certificate of each car which appeared on the list. Immediately I received this list a 'spot notice' of 'accepted' cars was sent twice daily to the cleaning elevator and a 'disposition sheet' with same particulars to the railroad company. (See Exhibit, Spot Notice and Disposition Sheet.)

Upon its receipt into store in the cleaning elevator the car was officially weighed, and afterwards cleaned two or more times under the immediate supervision of the provincial government's representatives (oftener if necessary), before the grain was run to the bagging machine, who drew an average sample of the recleaned grain, same being carefully sent over daily to the chief inspector's office and filed away in a tin box, with full particulars, date, elevator cleaned at, car number, &c. These samples were then examined by Mr. Horn, and if not up to the mark he consulted me as to further treatment, and if necessary the car was ordered back to elevator again and recleaned. In some cases where it was impossible to fit the car for seed owing to cockle, &c., I forwarded it to Fort William and sold it at current market price. I desire, however, to emphasize the point that every car of seed grain that was distributed for seed was cleaned not less than twice, and frequently three or four times before being sacked, loaded into cars and shipped to the country. The provincial inspectors while the grain was running over the cleaners used the regulation No. 10 sieve from time to time to determine whether the grain was clean enough. The Crown Elevator Company, at St. Boniface, is the best equipped cleaning elevator in the west. For commercial purposes it can clean, receive and ship twenty cars in ten hours; but for seed purposes about six cars were all that they could clean in that time. One day (twenty-four hours) thirteen cars were ru nthrough. I merely state this to show the relative speed the grain could be run through this elevator for seed as compared for ordinary commercial purposes. On the whole the provincial government inspectors did their work faithfully and well. They all felt that the reputation of their province was at stake, and would suffer if they failed in their duty. In proof of this I may be permitted to point out that out of over 1,600,000 bushels of seed grain purchased, there were only six or seven cars that exception could be reasonably taken to.

As a matter of fact the elevators cleaned their grain better than I expected. The principle of construction for elevator cleaners is entirely different to the farm fanning mill. For really clean work the latter is best, and knowing this and also knowing it would be impossible to purchase the vast amount of seed perfectly pure that was required, I had deposited printed cards in each sack of recleaned grain, advising the recipient to clean it himself before sowing it.

Complaint has been made that some cars shipped were not thoroughly cleaned, but as I have already reported on this matter it will be unnecessary to again refer to it, except to add that on the whole a most exceptional lot of seed grain has been distributed. In fact both Mr. G. H. Clark and Mr. Eddy reported to me that it was better than 90 per cent of seed grain exhibited at our local shows. I have personally examined probably 75 per cent of the samples of cleaned, sacked grain shipped and distributed, and from a close examination of them it is evident that most careful work has been done by the cleaning elevators, and equally careful supervision exercised by the government's representatives charged with looking after the cleaning.

When reports were recived that grain was unsatisfactory, a deputy grain inspector was sent to the point to investigate the charges made, and when it was established there were reasonable grounds for the complaint, fresh seed was substituted in every possible case.

Under instructions from Mr. David Horn, Chief Grain Inspector, a deputy grain inspector was stationed at each cleaning elevator throughout the entire cleaning operations. The services of these officers were most valuable, especially when called upon to act in an advisory capacity with the provincial government's representatives.

Owing to the necessity of grain having to be purchased at Winnipeg, Brandon, Regina, Moosejaw, Calgary, Edmonton, Strathcona, &c., &c., it was impossible to keep in close touch with the daily purchases; it was also impossible to estimate the quantity of grain that could or would be bought at each of these points, or the total quantity that would be required for seed, and although I discontinued buying in Alberta on March 11, and Winnipeg on the 18th, it was found when deliveries were complete that there was a surplus over requirements. This also applied in the case of the British purchases, as until the grain was actually inspected on the quay, it was impossible to know how much would be accepted and how much rejected.

Acting under advice of the Alberta government, I appointed Mr. George Harcourt, Deputy Minister of Agriculture, as my purchasing agent for that province. Mr. Harcourt appointed Mr. C. Nairn as his representative at Edmonton and Mr. W. Carson at Calgary.

It appeared to me that was the only thing to do under the circumstances, especially as I felt all seed grain that could be purchased in that province should be bought there, to ensure prompt delivery besides saving extra freights.

From time to time I received reports from Mr. R. E. A. Leech, Regina, showing number of applications and amounts of various kinds of grain required for seed. The first of these reached me on March 8, at which time 9,470 applications had been received, the last of such reoprts I recived on April 8, as follows:—

Number of applications, 15,275. Bushels of wheat, 514,772. Bushels of oats, 677,572. Bushels of barley, 89,649.

Upon requisition from Mr. Leech the first shipment of cleaned seed grain comprising twenty-three cars left Winnipeg on March 3.

I attach hereto a statement showing summary of seed grain on requisitions and petty cash sales shipped to Saskatchewan and Alberta:—

Saskatchewan—		
Total wheat on requisitions..	466,698 15	
Total oats on requisitions..	548,800 03	
Total barley on requisitions..	23,336 00	
		1,038,834 18
Alberta—		
Total wheat on requisitions..	30,820 00	
Total oats on requisitions..	192,730 11	
Total barley on requisitions..	23,640 00	
		247,190 11
Sold Saskatchewan government..		1,286,024 29
Garton's oats..		1,452 24
Sold Alberta government—		
Wheat..	2,090 00	
Oats (Garton's)..	21,539 08	
		23,629 08
		25,081 32
Petty cash sales—		
Total wheat..	1,082 15	
Total oats..	13,686 07	
Total barley..	40 00	
		14,808 22
Grand Total..		1,325,915 15

Number of stations seed grain shipped to in Saskatchewan..	155
Number of stations seed grain shipped to in Alberta..	50

The number of stations in Saskatchewan and Alberta the grain was shipped to will show less than the number seed was actually distributed at, as the cars I shipped were billed to destination ordered by Mr. R. E. A. Leach. In many cases only part of car was unloaded at such destination. The balance being forwarded to flag stations or others of which I have no record.

When it became evident there was a surplus of seed wheat and oats on hand over the requirements the fact was reported to you, also to the Saskatchewan and Alberta governments, who after duly considering the matter authorized me to dispose of same for cash at the regular sale prices. The sale of the surplus seed was well advertised in the press and resulted in my disposing of, in small and large lots, 13,686·07 bushels English oats, 1,082·15 wheat and 40 bushels barley, in all 589 cash sales were made, and the price realized from such sales I deposited to a special trust account at Bank of British North America, Winnipeg, a statement of all such sales, as well as of sales of all cars of grain that were accepted for seed and subsequently rejected up to 1st of June was transmitted to your department early last June.

There was a profit on the option account amounting to $8.109.37, which sum was transmitted to your department on 1st June.

Cleaned grain was in accordance with the provisions contained in the order in council shipped upon receipt of Mr. Leech's requisition in writing, but as upwards of 240 cars were loaded with cleaned sacked grain before any requisitions came to hand, I frequently found I could not fill the requisitions exactly in accordance with Mr. Leech's order. Some shipments were under and some over the amount called for. I might explain that as soon as a car was loaded at an elevator it was sealed and then removed by the railroad company to the hold-out track in the railway yards, perhaps miles away—even had they remained adjacent to the elevator it would have been most unwise to have broken the seals in order to reload the cars exactly to the requisitions, as once car seals had been broken neither the railway companies nor the elevators would have recognized any claims for shortage. The whole plan would have worked out better had Mr. Leech been able to get in his applications for seed grain advances a month earlier than he did, then cars could have been loaded exactly to a bag as required. Unfortunately, however, he only commenced receiving applications about the time I started cleaning operations. I repeat it was unfortunate he had not the opportunity to start a month earlier. I must, however, express my appreciation of the promptitude with which his office handled the large number of applications, and forwarded to me the requisitions for shipment.

The care exercised in selecting cars for seed purposes can be more properly illustrated by explaining that during the time I was on the market there were inspected at Winnipeg the following number of cars of wheat of grades required for seed:—

	Cars.
1 Hard	3
1 Nor.	380
2 Nor.	590
3 Nor.	872
No. 4.	543

or a total of 2,388 cars, which were carefully inspected for seed, out of which only 555 cars were accepted, or, in other words, only 23¼ per cent of total cars inspected while I was on the market were accepted as satisfactory. This fact alone will, clearer than any words or mine, demonstrate the care and vigilance exercised in making the selections. While for the local oats 339 cars of 1 and 2 white were inspected and 260 of these accepted, or 33 per cent of these grades were rejected, notwithstanding 25 wild oats to the pound were allowed.

The work of compiling the prices farmers were to be charged for the different grades of seed wheat was taken in hand the evening of March 7, and at that time the following was the actual cost as shown by my office records:—

1 Northern cost per bushel, including 1½ per cent cleanings	$1 02½
Freight	0 05½
Handling	0 03
Sacks	0 04¼
Loading	0 02¾
	$1 18

2 Northern cost per bushel, including 3 per cent cleanings	$1 00¼
Freight	0 05½
Handling	0 03
Sacks	0 04¼
Loading	0 02
	$1 15

3 Northern cost per bushel, including 2½ per cent cleanings	$0 91
Freight	0 05½
Handling	0 03
Sacks	0 04¼
Loading	0 03¼
	$1 07

No. 4 cost per bushel, including 3 per cent cleanings	$0 85
Freight	0 05½
Handling	0 03
Sacks	0 04¼
Loading	0 03¼
	1 01

I deferred approximating the price to be charged to the farmers as late as possible, in order to make a close calculation of the actual cost. Over one hundred cars had been shipped and arrived at destination before I computed the price, and as farmers were clamouring for the seed, I could not delay the matter any later than I did. However, to guard against any subsequent raise in price, and to provide for the payment of premiums, which had been inaugurated about that time, after careful consultation with the accountant, I loaded or added to the actual cost of the grain as shown on my books, as follows:—

1 Northern	2¾c.
2 "	2c.
3 "	3¼c.
No. 4 wheat	3¼c.

The following were the prices charged the farmers for the various grades of wheat:—

1 Northern	$1 18
2 "	1 15
3 "	1 07
No. 4	1 01

Local oats, the prices to farmers were for 1 and 2 white 70 and 67 cents per bushel.

Imported oats	85c. per bushel.
Imported barley	$1.13 per bushel.

In order to lessen the cost of seed grain to farmers, an arrangement was made with the railway companies whereby a flat rate of 9 cents per hundred pounds was charged from any point in Saskatchewan or Manitoba to Winnipeg and return to any point in Saskatchewan, that is to say, grain was shipped from any point on the Canadian Pacific Railway or Canadian Northern Railway in Saskatchewan or Manitoba to cleaning elevators at either Winnipeg, Brandon, Regina or Moosejaw and return, after being cleaned, to any point in Saskatchewan on same line of railway for 9 cents per one hundred pounds, while if shipments originated in Manitoba or Saskatchewan and after recleaning they were returned to Alberta the rate was 10 cents per one hundred pounds. The rate from any point in Alberta to cleaning elevators at Calgary or Edmonton, including the return of the cleaned grain to any point in that province on same line of railroad, was 9 cents per one hundred pounds.

Unfortunately, the full benefits accruing from these special seed rates were in a measure lost owing to the fact that much more wheat was purchased at points on the Canadian Northern Railway than was required to be distributed as seed on that company's lines, while more oats originated at the Canadian Pacific Railway points than was required for seed on their lines. The railway companies would not allow wheat tonnage originating on one line to be cancelled out with similar oat tonnage originating on another line or vice versa. This resulted in a greater expense for freight than was originally contemplated, as a special seed mileage freight rate had to be paid out in addition to the 9 cents per one hundred pounds already paid in.

In addition to the reduction of freight rates above referred to, the Canadian Pacific Railway lowered the ocean freight from Great Britain to St. John from 17 shillings to 11 shillings per ton on the imported British oats and the rate from St. John to Winnipeg was also lowered from 55 cents to 30 cents per one hundred pounds.

When the matter was first taken up with Sir Thomas Shaughnessey and Messrs. McKenzie & Mann, both agreed to co-operate to the fullest extent with the governments concerned and the lowering of the rates by the two companies has lessened the cost to the farmers to that extent and formed a handsome contribution towards the seed grain movement. In addition thereto both companies arranged with their country station agents to deliver free of cost the seed grain to settlers, added to this being the additional duty of seeing that the liens and mortgages were duly executed before the seed was distributed. Now, as seed was distributed at 205 stations in the two provinces at which there were agents, the saving to the government in this case is very material.

In concluding this interim report, I wish to say that the lateness of the date at which the purchasing operations were started has made the work most strenuous—for every officer engaged. I would be quite remiss in my duty if I neglected mentioning that no member of my staff has spared him or herself—and when I made requests for work to be done either at night or on Sundays (as I frequently had to do) it was always cheerfully responded to. Personally I greatly appreciate that Mr. C. H. Beddoe, chief accountant of your department, was authorized to attend to the payment of cheques issued under my authority for the purchase of seed grain. I have found him a most careful, exacting and efficient officer. Every voucher he carefully checked over before a settlement was made, and I found him a true friend, and one whom I could always rely in time of trouble, and that was pretty frequent.

To my accountants, Messrs. C. B. Piper and subsequently Mr. R. J. Howden, I must express myself obligated for their assistance in organization of the office records and their subsequent faithful services. It might be said that because I took both of these gentlemen out of grain offices that in the ordinary nature of things they could not be as true to me—as to their former employers—but I distinctly must state—no officers could have given truer or more faithful services to the government than these two have.

I have the honour to attach the following schedules as a part of this report:—

Exhibit 'A'—Advertisement published in the western press *re* the purchase of seed grain.

" 'B'—Further advertisement regarding the purchase of government seed grain.

" 'C'—Particulars showing number of sacks purchased and from whom.

" 'D'—Statement of option account with details attached.

" 'E'—Form of contract entered into when purchases were first made from elevator companies on a basis of May prices.

" 'E-2'—Cancellation of original contracts with elevator operators with whom I had made contracts similar to Exhibit 'E,' substitution contract was made in the form of Exhibit 'E-2.'

I have the honour to be, sir,
Your obedient servant,

CHARLES C. CASTLE,
Purchasing Agent.

SEED GRAIN ADVANCE—PURCHASING DEPARTMENT.

Re Government Seed Grain—Schedule 'A.'

The undersigned has been appointed by the Federal, Saskatchewan and Alberta governments to purchase grain in carlots only, suitable for seed, as follows : Wheat, Nos. 1 and 2 Northern, and if there is not sufficient of these grades then 3 Northern and No. 4, when purchased west of Winnipeg ; white oats, Nos. 1, 2 and 3; barley, Nos. 1, 2, 3 extra and 3.

The above grades will be purchased basis in store Fort William, official weights and grades to govern in all cases, subject to my right of rejecting any cars rejected by the grain inspector as unsuitable for seed.

All grain must be free from wild oats, darnel and cockle.

If provision can be made to secure qualified grain inspectors, grain will be re-cleaned at Winnipeg, Saskatoon, Regina and Moosejaw.

Seed grain for the province of Alberta will, as far as practicable, be recleaned and distributed from Calgary.

All grain will be bought at current market prices, date of inspection, plus a reasonable premium, dependent upon its vitality and suitability for seed purposes, subject to the conditions as above set forth.

Re Billing.

Until further notice, owing to an arrangement with the railroad companies regarding freight rates, all grain for seed purposes fulfilling the above conditions, no matter where originating must be originally billed to Fort William or Port Arthur. Farmers and others shipping carlots of grain will bear this in mind.

As soon as arrangements are completed for receiving grain at interior re-cleaning points, an announcement will be made as to billing of same. Meantime, bill to Fort William or Port Arthur, as above advised.

CHARLES C. CASTLE,
Purchasing Agent.

P.O. Box 1327, Winnipeg.

Re GOVERNMENT SEED GRAIN.

Schedule 'B.'

Supplementing my previous announcement, I am in the market to purchase grain in car lots only, suitable for seed for government seed purposes, as follows:—

Wheat, Nos. 1 and 2 Northern; and if there is not sufficient of these grades, then 3 Northern and No. 4, when purchased west of Winnipeg.

White oats, Nos. 1, 2 and 3.

Barley, 1, 2, 3 Extra, and 3 .

These grades will all be purchased basis in store Fort William, except as hereinafter noted. Official weights and grades to govern in all cases, subject to my right of rejection of any cars rejected by the Grain Inspector as unsuitable for seed. No bulkhead cars will be accepted.

It is inadvisable to send in samples of grain, as I cannot make selection except upon inspection of the entire car lot. All shippers must ship on their own judgment, and run the risk of the grain being rejected for seed purposes.

The prices paid for grain depend upon its suitability for seed, according to the conditions laid down by the Dominion Seed Commissioner. No grain whatever will be accepted if it contains any darnel, ragweed, sow thistle, or Canada thistle. The term 'noxious weed seeds,' as used below, means wild oats and purple cockle.

Standards and Prices for Wheat.

After this date, all wheat prices are 'in store' Fort William or Port Arthur, and are based on May price date of inspection—current spreads for different grades to govern.

A.—Containing no noxious weed seeds whatever..						20c.	premium.
B.—	"	maximum of 1 noxious weed seed per lb.				15c.	"
C.—	"	"	5	"	"	10c.	"
D.—	"	"	8	"	"	5c.	"

E.—If wheat does not classify in A, B, C or D, and contains maximum of 10 wild oats or 20 purple cockle per pound, it will be accepted, but no premium will be allowed, provided that if the wheat contains a maximum of 5 wild oats per pound, a maximum of 10 purple cockle only will be allowed for acceptance. Wheat containing more than any of these maximums will be rejected.

Standards and Prices for Oats.

All oats must be of the White variety, sound and of good vitality. After this date prices are based on an arbitrary basis of 65c. for 2 White 'in store' Fort William or Port Arthur, except for Alberta, where prices are detemined by Deputy Minister of Agriculture, George Harcourt, Edmonton. A spread of 1c. premium shall determine price of 1 White, and a spread of 3c. discount shall determine the price of 3 White.

A.—Containing no noxious weed seeds whatever..						20c.	premium.
B.—	"	maximum of 1 noxious weed seed per lb.				15c.	"
C.—	"	"	10	"	"	10c.	"
D.—	"	"	20	"	"	5c.	"

E.—If oats do not classify in A, B, C or D, and contain a maximum of 25 wild oats or 25 purple cockle per pound, they will be accepted, but no premium will be allowed, provided that if both oats and purple cockle are present, the maximum number must not exceed 25 per pound. Oats containing more than these maximums will be rejected.

Barley.

At present I am not in the market for any barley whatever. An announcement as to barley will follow later.

Rebilling.

I have now completed arrangements to reclean grain at Edmonton, Calgary, Moosejaw and Regina.

Grain shipped for seed must never be billed west, as the railway companies refuse to handle grain west and then east again over the same line, except upon local rates plus through rates from extreme western station.

If the following directions as to billing are followed exactly, grain may be consigned to me at these interior cleaning points, and if rejected for seed purposes, will be forwarded to the lake terminal Fort William or Port Arthur, without any stop over charge, and upon the through rate as applying from point of origination. In every case grain must be billed to the order of C. C. Castle. Advise C. C. Castle, Winnipeg.

Destination is determined as follows:—

Everything in Alberta on the Canadian Pacific Railway lines (except the main line east of Calgary) must be billed to Calgary.

Everything north and west of Edmonton on the Canadian Northern Railway lines may be billed to Edmonton.

Wheat on the Soo line, Tuxford line, and on the main line west of Moosejaw, may be billed to Moosejaw. Oats on these lines must be billed to Regina.

All grain on the Arcola line, Prince Albert line from Saskatoon south, and the main line east of Moosejaw, may be billed to Regina.

All grain from all other points must be billed to Fort William or Port Arthur. As far as possible this grain will be cleaned at Winnipeg. The bill of lading, in all cases, even when billed to interior points, must be sent to me at Winnipeg. Always advise me to whom you wish me to turn over your bill of lading, in case the car is rejected for seed purposes, as I cannot handle grain which has been rejected.

If the shipper chooses he may consign his Fort William or Port Arthur shipments to any regular dealer in Winnipeg, billed to his advice. In any event the advice must be Winnipeg, and the bills of lading must be in Winnipeg when the car arrives.

In consigning cars to C. C. Castle, do not draw any advances, as the government will not honour the drafts. Send in your bill, and settlement will be made as soon as the cars are unloaded.

CHARLES C. CASTLE,
Purchasing Agent,
Box 1327, Winnipeg.

Box 1327, Winnipeg.

EXHIBIT C.

Name.	Wheat.	Oats.	Barley.
Nicholson & Bain..	65,000		
R. J. Whitla & Co..	65,000		
Merrick, Anderson & Co..	65,013	51,000	
Smart Bag..	165,000	113,954	5,000
Bemis Bros..	175,000	56,000	
	535,013	220,954	5,000

Total wheat..	535,013
Total oats..	220,954
Total barley..	5,000
	760,967

Checked and found correct.

R. J. HOWDEN.

SCHEDULE D.

WINNIPEG, May 30, 1908.

STATEMENT of funds deposited to the credit of C. C. Castle's Trust Account (Seed Grain Department) being moneys received for credit option account as per summary herewith.

No. 1	acct. P. and S. by	Saskatchewan Elevator Co.	$ 135 00
No. 2	"	International Elevator Co.	1,150 00
No. 3	"	Imperial Elevator Co.	62 50
No. 4	"	Western Elevator Co.	1,456 25
No. 5	"	Northern Elevator Co.	750 00
No. 6	"	Winnipeg Elevator Co.	25 00
No. 7	"	Northern Elevator Co.	1,518 75
No. 8	"	Parrish & Lindsay.	388 12
No. 9	"	Parrish & Lindsay.	even
No. 10	"	North Star.	743 75
No. 11	"	Imperial Elevator Co.	506 25
No. 12	"	Canadian Elevator Co.	181 25
No. 13	"	Canadian Elevator Co.	287 50
No. 14	"	Canadian Elevator Co.	925 00
		Total credit C. C. Castle.	8,129 37
No. 15	"	Winnipeg Elevator Co. debit.	20 00
		Total amount at credit option account.	8,109 37

Checked and found correct.

R. J. HOWDEN.

WINNIPEG, March 11, 1908.

Account purchase and sale by Saskatchewan Elevator Co.

March 13,	Sold 10 M. bushels at $1.09⅝.		$10,962 50
	Delivered about 5,500 bushels.	$6,029 38	
March 7,	Bought 5 M. May, H. McBean & Co., at $1.12¾.	5,073 75	
	Commission ⅛.		5 63
	Balance.		135 00
		$11,103 13	$11,103 13

At credit C. C. Castle $135.

WINNIPEG, March 6, 1908.

Account purchase and sale by International Elevator Co.

February 14,	Bought 20 M. May, H. McBean & Co., $107¾.	$21,550 00	
March 4,	Sold 10 M. May, B. McBean & Co., at $1.14.		$11,400 00
March 5,	Sold 10 M. May, W. C. Leistikow, at $1.13.		11,300 00
			$22,700 00
	At credit C. C. Castle.		1,150 00

WINNIPEG, March 21, 1908.

Account purchase and sale by Imperial Elevator & Lumber Co.

March 11, Sold 5 M. bushels Winnipeg, May, $1.12¼..		$5,612 50
Bought 5 M. bushels, Winnipeg, May, $1.10⅞..	$5,543 75	
Commission ⅛..	6 25	
At Credit C. C. Castle..	62 50	
	$5,612 50	$5,612 50

March 5, 1908.

Account, purchase and sale by Western Elevator Co.

February 13, Bought 10 M. bush., $1.11..	$ 11,100 00	
15 M. bush., $1.10⅞....	16,631 25	
5 M. bush., $1.10½	5,525 00	
10 M. bush., $1.10⅜..	11,037 50	
		$ 44,293 75
February 28, Sold 40 M. bush. at $1.14½..		45,800 00
Gain...		$ 1,506 25
Commission ⅛..		50 00
At credit C. C. Castle..		$ 1,456 25

WINNIPEG, March 5, 1908.

Account, purchase and sale by Northern Elevator Co.

February 29, Sold 25,000 bush. 1 Northern, $1.10..	$ 27,500 00	
March 5, Cancelled 25,000, $1.13⅛..		$ 28,281 25
Commission..	31 25	
At credit C. C. Castle..	750 00	
	$ 28,281 25	$ 28,281 25

WINNIPEG, March 2, 1908.

Account, purchase and sale by Winnipeg Elevator Company.

March 2, bought 10 M. bush. May wheat at $1.13..	
Sold 10 M. bush May wheat at $1.13⅜..	
Gain..	$ 37 50
Less commission ⅛..	12 50
	$ 25 00
At credit C. C. Castle....	$ 25 00

WINNIPEG, February 29, 1908.

Account purchase and sale by Northern Elevator Company.

February 29. Sale 40 M. cash wheat at $1.10	$44,000 00	
May option sold as follows:—		
5 M. bus., $1 13¾		$5,687 50
5 M. bus., 1 14		5,700 00
5 M. bus., 1 13⅞		5,693 75
5 M. bus., 1 13⅞		5,693 75
5 M. bus., 1 14		5,700 00
5 M. bus., 1 14		5,700 00
5 M. bus., 1 14		5,700 00
5 M. bus., 1 13⅞		5,693 75
Commission	50 00	
At credit C. C. Castle	1,518 75	
	$45,568 75	$45,568 75

WINNIPEG, February 29, 1908.

On account purchase and sale by Parrish & Lindsay.

Bought	5,000 at $1 13½	$5,675 00	
	15,000 at 1 13⅝	17,043 75	
	30,000 at 1 13	33,900 00	
	25,000 at 1 13	28,250 00	
			$84,868 75
Sold	10,000 at 1 13½-⅝	11,356 25	
	25,000 at 1 13	28,250 00	
	10,000 at 1 13⅝	11,362 50	
	10,000 at 1 14⅜	11,437 50	
	10,000 at 1 14½	11,450 00	
	10,000 at 1 14⅝	11,462 50	
			85,318 75
			$450 00
	Commission, $\frac{1}{16}$		46 88
	To credit C. C. Castle		$403 12
	Less interest on margins		15 00
			$388 12

WINNIPEG, February 28, 1908.

On account purchase and sale by Parrish & Lindsay.

January 29, Bought 25,000 at $1.09	$27,250 00	
February 28, Sold 25,000 at 1.09⅛		$27,281 25
Commission	31 25	
	$27,281 25	$27,281 25

WINNIPEG, March 7, 1908.

On account purchase and sale by North Star Grain Company.

February 29,	Sold 15,000 May, \$1.12¾		\$16,912 50
March 6,	Sold 14,000 May, 1.13½		15,890 00
February 14,	Bought 4,000 1 Nor., \$1.10⅞	\$ 4,435 00	
	20,000 1 Nor., 1.10¼	22,050 00	
	5,000 1 Nor., 1.10¾	5,537 50	
	Commission ⅛	36 25	
	At credit C. C. Castle	743 75	
		\$32,802 50	\$32,802 50

WINNIPEG, March 2, 1908.

On account purchase and sale by Imperial Elevator and Lumber Co.

February 29,	Sold 15,000 Wpg. May, \$1.12½		\$16,875 00
	5,000 Wpg. May, 1.12½		5,625 00
	5,000 Wpg. May, 1.12⅜		5,618 75
	10,000 Wpg. May, 1.12⅜		11,237 50
	Bought 35,000 Wpg. May, \$1.10⅞	\$38,806 85	
	Commission ⅛	32 75	
	At credit C. C. Castle	506 25	
		\$39,356 25	\$39,356 25

WINNIPEG, March 6, 1908.

On account purchase and sale by Canadian Elevator Co.

Bought May option wheat 5,000, \$1.10	\$5,500 00	
Sold May option wheat 5,000, \$1.13¾		\$5,687 50
Less commission ⅛	6 25	
At credit C. C. Castle	181 25	
	\$5,687 50	\$5,687 50

WINNIPEG, March 6, 1908.

On account purchase and sale by Canadian Elevator Co.

Feb. 11,	Bought May option wheat, 10,000, \$1.10	\$11,000 00	
Mar. 5,	Sold May option wheat, 10,000, \$1.13		\$11,300 00
	Less commission ⅛	12 50	
		\$11,021 50	\$11,300 00
	At credit C. C. Castle	287 50	
		\$11,300 00	\$11,300 00

WINNIPEG, March 2, 1908.

On account purchase and sale by the Canadian Elevator Co.

Feb. 11,	Bought May option, 25,000 bushels, $1.09⅞	$27,468 75	
Feb. 28,	Sold May option, 20,000 bushels, $1.13¾		$22,750 00
	Sold May option, 5,000 bushels, $1.13½		5,675 00
	Less commission ⅛	31 25	
		$27,500 00	$28,425 00
	At credit C. C. Castle	925 00	
		$28,425 00	$28,425 00

WINNIPEG, March 9, 1908.

Account, purchase and sale by Winnipeg Elevator Company.

Bought 12,000, May, $1.13	
Sold 10,000, May, $1.13	
Sold 2,000, May, $1.12¾ De	$ 5 00
Commission ⅛	15 00
At debit C. C. Castle	$ 20 00

SCHEDULE 'E.'

CONFIRMATION OF SALES.

The Canadian Elevator Company, Limited.

C. C. CASTLES, Esq.,
Warehouse Commissioner.

We confirm the following sales to you to-day :—

Thirty thousand bushels (30 M.) at $1.10.

Twenty-five thousand bushels (25 M.) at $1.09⅞, basis, one northern—two northern to be applied at two (2) cents diseount—three northern at eight (8) cents discount. No. four wheat at fifteen (15) cents discount. Delivery, Winnipeg basis, Fort William freight.

To be shipped from country points as fast as cars are obtained.

Purchaser has privilege of rejecting wheat not suitable for seed purposes on account of wild oats and noxious weeds.

THE CANADIAN ELEVATOR CO., LIMITED.

Checked and found correct, (Sgd.) 'GODFREY.'

R. J. HOWDEN.

SCHEDULE 'E'—2.

C. C. Castle, Winnipeg, Man., March 5, 1908.
Purchasing Agent,
Winnipeg, Man.

Dear Sir,—We hereby agree to cancel and do cancel all our sales to you of wheat for future delivery, according to the terms of our contracts dated February 29, 1908, and February, 1908, upon the conditions that you account to us for losses occasioned in our selling the May options at the market to cover the final unfilled portion of the above mentioned contracts, and that we account to you for gains so occasioned.

We agree to ship out our 1 Northern, 2 Northern, 3 Northern and No. 4 Wheat as rapidly as cars are obtainable, from the following points :—

Vonda, Howell, Borden, Saskatoon, Hanley, Hague, Rosthern.

In consideration you agree to accept and pay for all wheat desirable for seed of the said grades shipped from the said stations, subject to the conditions and premiums hereinafter set forth.

All wheat shall be rejected if it contains any darnel, ragweed, sow thistle or Canada thistle. The term 'noxious weed seeds' as used herein shall include wild oats and purple cockle in addition to the aforementioned weed seeds. All wheat containing more than the maximum of seeds allowed hereinafter shall be rejected. All bulkhead cars shall be rejected.

Premiums on accepted cars will apply as follows:—

A. Containing no noxious weed seeds whatever, 20 cents.

B. Containing maximum one noxious weed seed per pound, 15 cents.

C. Containing maximum five noxious weed seeds per pound, 10 cents.

D. Containing maximum eight noxious weed seeds per pound, 5 cents.

E. If wheat does not classify in groups A, B, C or D, and contains maximum of ten wild oats or twenty purple cockle per pound, it will be accepted, but no premium will be allowed: Provided that if the wheat contains a maximum of five wild oats per pound, a maximum of ten purple cockle only shall be allowed for acceptance.

Price and premium shall be based upon closing May price in store at Fort William or Port Arthur at date of inspection, and the spreads for 1 Northern, 2 Northern, 3 Northern, and No. 4 shall be three, eight and fifteen cents respectively.

You agree to pay storage in lake terminals up to and including May 1, 1908, on all cars of the above mentioned grades shipped from the above mentioned stations, if said cars are rejected as being undesirable for seed purposes, and actually go into store in said terminals as determined by surrender of terminals out-turns.

No provisions of this contract shall be retroactive. All deliveries on previous contracts shall be settled upon prices of such contracts and without premiums. This contract shall become operative upon execution by both parties. It shall cease and become inoperative upon forty-eight hours' notice in writing from you to that effect. You agree to apply upon this contract all cars otherwise applicable to this contract received and inspected at Winnipeg up to and including the last day of the expiration of said forty-eight hours' notice, but it is provided that no cars received and inspected at Winnipeg after the expiration of said notice shall be applied upon this contract.

The provisions of this contract as to prices and premiums but not as to indemnity of terminal storage charges shall apply to all of our wheat coming forward from any station west of Winnipeg.

Dominion weights and grades shall govern in all cases. The seed commissioner's inspection, upon official sample, shall be final as to the desirability for seed and consequent determination of premiums. Bills of lading shall be surrendered without advances upon notice from you, and cars shall be invoiced when complete.

Approved: CANADIAN ELEV. CO. L.
(Sgd.) A. K. Godfrey.

Approved: (Sgd.) CHARLES C. CASTLE,
Purchasing Agent.

REPORT OF THE DISTRIBUTING AGENT.

REGINA, SASK., June 22, 1908.

W. W. CORY, Esq.,
Deputy Minister of Interior,
Ottawa, Ont.

DEAR SIR,—In connection with seed grain distribution work, I beg to make an interim report, as follows:—

At the request of the Minister of the Interior, I took charge of the distribution of seed grain in the provinces of Saskatchewan and Alberta, as per the agreements entered into between the Minister of the Interior and the representatives of the Saskatchewan and Alberta governments. In Ottawa, in the latter part of January and first of February, I arranged for the printing and distribution of notices and circulars regarding the terms and conditions of the proposed seed grain distribution, forms of application, liens, mortgages, &c.

On February 11, I arrived in Regina to open offices and organize a staff for handling the work. By the terms of the regulations governing the seed grain distribution, applications were to be made in duplicate before the secretary-treasurers of local improvement districts, Dominion land agents, sub-land agents, homestead inspectors, immigration agents or Northwest Mounted Police; the original application form to be immediately forwarded to my office, afterwards to be forwarded to the various land offices, or provincial authorities, for verification as to the interest of applicants in the lands described; the duplicate to be approved, or otherwise, by the council of the local improvement district and subsequently forwarded to me.

In order to meet the requirements of Section 13, of the agreements made in Ottawa, February 3, between the Minister of the Interior and the representatives of the Saskatchewan and Alberta governments, respectively, I was notified that Mr. D. S. McCannel was appointed to represent the Saskatchewan government, and Mr. George Stevenson was appointed to represent the Alberta government. Those representatives opened offices, convenient to my own, and their approval was had to all applications made by non-homesteaders, for the respective provinces, before seed was delivered.

In order to facilitate keeping an accurate and readily available record of applications, I prepared registers and divided the work by land districts. In those registers the following notations are made:—

'Application number,' 'name,' 'post office address,' 'description of land,' 'original application received,' 'amount applied for,' 'date original application sent land office,' 'date original application sent provincial government,' 'date original application received back,' 'amount finally recommended,' 'papers sent railway agent, giving date and station,' 'date lien received from railway agent,' 'amount of seed supplied, wheat, oats and barley,' 'amount charged to governments, Dominion, Saskatchewan, Alberta, and cash sales.'

On February 13, the first applications were received. February 22 was the first date fixed for closing applications. The time for receiving applications, however, was extended from time to time and was, eventually, left open. The last application received was June 16, and seed was delivered on this application. Altogether 16,615 applications were received and dealt with by this office.

As applications were finally approved they were listed for shipment under the stations at which the applicants desired their seed delivered. Each day, as the approved applications for any railway station made up a car lot of any given grain, a requisition was issued upon Mr. Charles C. Castle, purchasing agent, Winnipeg, for the shipment of the same. The first of such requisitions was made February 28, for 26 cars, and daily requisitions, as required, were made subsequently during the shipping season. The last requisition was made May 13. The total requisitions are as follows:—

	Cars.
Wheat	500
Oats	482
Barley	39

In addition to this, however, grain was shipped on the requisition of Hon. W. T. Finlay, for the province of Alberta, as follows :—

	Cars.
Wheat	2
Oats	14

which will also be accounted for through this office. In all, 1,037 cars of seed were shipped out for distribution.

When seed was shipped by Mr. Castle, the shipping bills were sent to this office, invoices accompanying the same, which were noted in our records. To the shipping bill for each car we attached a delivery list with liens and mortgages for execution by the applicants before the railway agents at time of delivery, it being necessary to take a separate mortgage, or lien, for each kind of grain owing to the deliveries being made at different times. For each car of seed the number of deliveries to be made to applicants varied from 20 to, in one instance, 121, requiring the execution of as many securities. The first shipping bills were received at this office March 11th and were for 67 cars, and on the same day were sent forward to the various railway agents (or in the case of flag stations, to homestead inspectors) with the necessary delivery lists, liens and mortagages attached ; also, each applicant was notified of the seed being shipped. As it was important that applicants should be able to receive the seed as soon as it reached its destination, we made it the rule of the office that all the shipping bills should be sent forward, with lists, liens, mortgages, &c., on the day that they were received, and I am pleased to be able to report, that while we received as high as 81 shipping bills in one day, none ever remained over night in our office.

Seed was delivered at 175 stations in Saskatchewan, and 75 stations in Alberta, making 250 stations in all; and the quantities ranged from a very few bushels up to, in one instance, 32 cars at one station.

In accordance with the arrangements made with the Canadian Pacific and Canadian Northern railways their agents made delivery of the grain at the railway stations, and had the necessary documents executed. This was a very important part of the work, and, on the whole, has been done in a satisfactory manner. Deliveries at flag stations were attended to by homestead inspectors.

Owing to the enormous amount of work in connection with deliveries, I arranged for homestead inspectors to supervise the work on all railway lines, allotting to each a certain territory, which they attended to in addition to flag stations. By this means railway agents having heavy deliveries were given assistance. As the deliveries for each car were completed the railway agent was requested to give a 'return statement' showing the deliveries as they had been made, on a form provided, and attach thereto the securities taken. Up to the present time these 'returns' and securities have not all been received at this office, but they will probably reach a total exceeding 30,000 in number. A separate file was made for each applicant to which was attached his application in duplicate, all correspondence in connection therewith, and the liens, mortgages or cash sale invoices taken in settlement for seed delivered.

As liens, mortgages or cash sale invoices are received they are entered into our 'out-turn' grain books and our 'application' register, and attached to the proper application files. When all liens, mortgages or cash sale invoices relating to an application file are received, the file with the securities is immediately transferred to Ottawa in the case of homesteaders, and to the provincial authorities respectively in the case of non-homesteaders.

Duplicates of non-homesteader's files are made, and the same forwarded to Ottawa.

At the present time, about 50 per cent of the files have been disposed of in the above manner.

RE UNSATISFACTORY SEED.

In every case where complaint was made about the seed supplied not being satisfactory, I immediately had an investigation made, in most instances by a deputy grain inspector, and where the seed, upon examination, was not thoroughly satsfactory I immediately stopped delivery of the same and requested applicants who had received such seed to return it, when satisfactory seed would be substituted. Many complaints, however, proved to be not well founded, and more particularly in connection with oats.

The earlier deliveries of oats were western grown. Later, when English oats were being delivered, being of much superior quality, many became dissatisfied with the western oats they had received. Up to the present time, however, I have not had a complaint that the oats supplied have failed to grow satisfactorily.

I have had a few complaints of seed wheat not giving satisfactory germination, and am having each case thoroughly investigated. So far as these cases have been reported upon, it is clearly evident that the seed was seriously injured by formalin treatment by the farmer previous to sowing.

ALLOTMENTS NOT CALLED FOR.

Considerable quantities of seed delivered to various points were not called for by applicants. These refer particularly to applications for barley. In the application form each applicant was asked to state, whether, in the event of the kind of grain applied for not being available, he would be satisfied to have some other kind of grain substituted. Almost invariably applicants consented to this suggestion.

In connection with barley it was found that only about one-third of the quantity required could be secured, and oats were therefore substituted on applications for barley. When those substituted oats arrived at destination points the farmers appeared to be disappointed in not receiving barley; and the season then being somewhat late, they, in a great many instances, preferred not to take oats. There were also many cases where people living long distances from the railway stations did not receive the notice of their grain being shipped, in reasonable time. Also, there were a number of cases where settlers had rivers and streams to cross to reach the railway station, and having to depend upon ferry crossings, which owing to high water, were unable to operate, they were disappointed in not being able to take the seed they required.

QUALITY OF SEED.

Out of 1,037 cars sent out for distribution the entire complaints received will only refer to about 15 cars, and of this number there does not appear to have been reasonable ground for complaint against more than 8 cars, which is quite a small percentage of the entire shipments.

The seed, generally, appears to have been carefully inspected and well cleaned. I have scores of letters expressing appreciation and satisfaction, both as to quality of seed, prices for the same, and the manner in which the business was handled in connection with seed distribution.

Owing to the very short time between the commencement of seed grain distribution operations and seeding time it required a large office staff to handle the business. For three months my staff of about 35 in number worked every day from 7 a.m. until nearly midnight, and sometimes even later. I am pleased, however, to be able to report that each day's business was cleared up on the day it was received, and that no oversight or miscarriage appears to have occurred in connection with a single application.

SEED GRAIN DISTRIBUTION A NECESSITY.

While the distribution did not reach the proportions anticipated, there is no question as to the necessity for making the distribution. In many districts seed was not available, and settlers had not the means to purchase the same. Owing to the general financial stringency settlers were unable to borrow, even upon good securities. I believe I am well within the mark in saying that 500,000 acres have been seeded which would not have been were it not for the present seed grain distribution. A considerable additional acreage would probably have been sown with inferior seed, which would have given poor results. This upon an average crop return will yield an extra eight or ten million dollars to the crop returns for this year in the provinces of Saskatchewan and Alberta.

Attached hereto please find schedules as follows:—

1. The number of applicants by land districts to whom seed grain was advanced, and whether upon homesteader's liens, seed grain mortgages or cash sales.
2. The number of applications rejected or cancelled, by land districts.
3. Statement of grain distributed at railway stations in Saskatchewan, showing the kind, quantities and grades of grain delivered.
4. Statement of grain distributed at railway stations in Alberta, showing the kind, quantities and grades of grain delivered.
5. A statement showing the total seed grain delivered.

I have the honour to be,
Your obedient servant,

R. E. A. LEECH,
Inspector, D. L. Agencies.

N.B.—Railway agents in some cases not having sent in final returns of deliveries made, the figures in the schedules hereto in some cases are approximated, and will be subject to correction when completed returns are available.

SCHEDULE No. 1.

No. OF APPLICANTS RECEIVING SEED GRAIN AND TERMS OF SETTLEMENT.

Land District.	Settlement by				
	Liens.	Mortgages.	Cash Sales.	Total.	——
Saskatchewan—					
Humboldt	1,472	302	21	1,795	
Battleford	728	131	....	859	
Prince Albert	215	154	....	369	
Regina	875	1,361	56	2,292	
Yorkton	1,501	2,100	84	3,685	
Moose Jaw	796	92	11	899	
Estevan	259	1,025	17	1,301	
Brandon	90	490	12	592	
	5,936	5,655	201	11,792	11,792
Alberta—					
Edmonton	1,125	1,047	144	2,316	
Lethbridge	90	27	13	130	
Red Deer	216	314	24	554	
Calgary	119	219	66	484	
	1,630	1,607	247	3,484	3,484
Total	....	....	....	....	15,276

SCHEDULE No. 2.

STATEMENT SHOWING THE NUMBER OF APPLICATIONS REJECTED AND CANCELLED.

Saskatchewan land district—	*Cancelled Application.*	
Humboldt	115	
Battleford	157	
Prince Albert	37	
Regina	127	
Yorkton	193	
Moosejaw	78	
Estevan	80	
Brandon	29	
	816	816
Alberta land district—		
Edmonton	265	
Lethbridge	23	
Red Deer	119	
Calgary	116	
	523	523
Total		1,339

SCHEDULE No. 3.

STATEMENT OF GRAIN DISTRIBUTED AT RAILWAY STATIONS IN SASKATCHEWAN.

Station.	Wheat.				Oats.			Imported.	Barley.
	1 Nr.	2 Nr.	3 Nr.	No. 4.	1 Wh.	2 Wh.	3 Wh.		
Aberdeen	628							13	
Abernethy	1,250		1,750			777		355	
Alameda			6,207	1,050				1,785	
Antler	700		2,883	3 075		5,111		663	
Arcola	2,750	1,050	4,805	4,858	336	2,960		682	
Asquith	1,050			1,309				1,170	
Balcarres	1.034	1,684	3,692			1,200		3,505	
Balgonie		2,232	3,436			1,800		2,013	348
Battleford		2,234	3,924	1,000		5,508		3,650	
Belle Plain			220					380	
Benito			1,050					2,035	
Bethune	1,000			1,419				1,214	
Bienfait		113	4,146					2,746	
Birch Hills		113						1,046	
Bladworth			1,530					970	
Blutcher	700			467				1,536	
Borden			905					490	
Bredenbury		205						297	159
Bresaylar		30						180	
Broadview	676		454	1,016				1,565	300
Brumo		200	1,090					1,102	
Buchanan			1,016					6,896	
Canora	830	2,324	2,966	1,008		1,722		29,022	1,187
Carievale		1,000	615					500	
Carlyle			3,196	9		1,710		235	
Caron			1,000					1,620	
Carnduff			1,181					640	
Chamberlain			1,727		89		1,056	861	
Churchbridge		650	902	710		1,800		2,095	429
Condie		1,050	200					55	
Craik			2,425	350		1,236		810	
Creelman	1,922	968	3,357	134		1,800		1,235	
Cupar	1,050	397	3,071	2,200		6,625		635	
Dana			2,448					2,247	
Davidson	1,050	1,050	2,628	3,044		1,836		3,620	1,250
Disley			1,040	609				379	
Drinkwater	253		640					2,678	
Dubuc	180	650	3,147	1,100		1,170		3,216	
Dundurn				1,785				1,084	
Duck Lake		115						157	
Earl Grey			3,617					1,018	
Ebor			455					72	
Elstow			1,553					1,352	
Englefeldt			653					1,400	175
Esterhazy	1,000			2,984		1,200		669	
Estevan	1,080	1,309		1,050				1,715	
Fairlight	1,218	128	745					1,425	
Fielding				262				225	
Fillmore			2,635	668		1,791		1,866	
Fleming	370							460	40
Foam Lake			443			2,228			174
Forget	2,008	3,736	8,199	5,087		8,038		200	1,250
Francis		2,072	3,864	1,050		200		1,939	
Frobisher	3,470	2,432	2,050	807		1,800		714	
Gainsboro	334		1,000	666		1,788		250	
Girvin			1,480					318	
Glen Ewen			2,930	682		173		1,382	
Govan		3,000	2,826	1,404		1,166		2,243	
Grayson	380	2,440	3,000	2,693		4,986		3,900	1,150
Grenfell			2,064	1,048		1,215		1,251	385
Quill Lake	972							2,160	
Hague			106						
Halbrite	1,000		1,670	1,400				1,325	
Hanley	637		1,082	261				775	
Harrowby			610					604	
Herbert	506	244	1,292			1,199		301	364
Heward			489	1,110		1,200		1,052	
Hirsch	2,050	3,780	3,449			2,157		641	
Hitchcock			605					245	
Humboldt			2,800					4,791	10
Indian Head		648	2,368					1,973	164
Insinger			575					1,200	13
Invermay		325						5,445	
Kaiser			1,632			1,239		1,103	
Kamsack	1,050			67				9,390	
Kenaston	792			1,038				1,083	
Kennedy				850				483	
Killaly		516	1,112					1,798	

SCHEDULE No. 3.

STATEMENT OF GRAIN DISTRIBUTED AT RAILWAY STATIONS IN SASKATCHEWAN.

Station.	Wheat.				Oats.			Imported.	Barley.
	1 Nr.	2 Nr.	3 Nr.	No. 4.	1 Wh.	2 Wh.	3 Wh.		
Kinistino		310						610	
Kisbey			1,314	3,010				1,952	
Kronau			100			1,320		548	
Kuroki		24	92					1,775	155
Lang			229					899	
Langenburg	1,597	996	692	1,573		7,986		1,205	682
Langham			202	129				170	
Lanigan	2,234		1,609			3,600		2,490	900
Lashburn	846	954	796			2,364		2,348	588
Lemberg	1,116		1,060	758		128		2,646	
Lipton	3,503	1,040	5,126	2,086		1,839		8,312	
Lockwood	1,050		127					674	
Lloydminster	1,070		2,280	1,000		3,621		9,712	2,705
Lumsden			1,624	978				610	
Macoun	2,086	1,314	4,029	4,998		3,555		192	594
Maidstone			1,239					1,767	147
Manor		975	3,379	1,105		1,800		1,329	
Maple Creek								202	
Marshall			566	999				1,885	524
Marchwell			1,394			1,800		654	
Margo		34						1,200	101
Maymont			968	75				514	
Melfort			1,050					2,965	
Midale	148	852	1,502					1,547	
Milstone			1,475			2,949			
Moose Jaw			1,050			1,701		320	
Moosomin			1,970					897	210
Morse			1,032			1,800		618	110
Mortlach	1,038		1,020	1,732		3,597		2,984	402
Muenster			2,160			2,607		1,512	440
McDowell								236	
McLean		1,050	366					1,540	140
McTaggart			490					180	
Neudorf		214	786	1,050		800		177	
Nokomis	2,138	2,596	1,058			3,270			
N. Battleford				977				1,194	
North Portal			120					200	
Orcadia			260			3,379		1,500	70
Osage		3,100	912					1,897	
Osler		55						104	
Oxbow	1,306		1,298	440				1,078	
Parkbeg			240					120	10
Pasqua			462					630	
Paynton		956						1,413	119
Pense								80	
Pilot Butte			95					320	50
Prince Albert		55						405	
Qu'Appelle		932	1,816			1,158		757	390
Quill Lake			747			1,903		3,032	692
Radisson	1,100		1,051	520				756	
Redvers	2,340	1,970	3,003	1,000		3,651		1,800	1,050
Regina		970	4,436	1,100				4,354	
Rocanville			528					462	
Roche Percee			25					78	50
Rokeby				324		5,895		3,620	211
Rouleau	947	1,050						1,419	
Rush Lake			100					300	
Saltcoats		1,878	2,996	1,026		13,153		9,639	716
Saskatoon	1,986		1,025	958				3,782	
Sedley			2,860					2,521	
Sheho	1,438		13			3,600		4,352	598
Sintaluta			1,052					330	100
Southey		687	532	768		2,297		44	
Springside			372			1,800		3,168	235
Star City	653		644					4,003	
St. Gregor			475					775	38
Stockholm		996	159					1,565	2
Stoughton	1,050	1,024	4,866	1,556		3,750		1,926	
Strassburg			1,319			430		289	
Swift Current		3,124	2,230			3,410		4,186	
Summerbery								78	180
Tantallon			535					562	
Theodore		979	138			2,578		5,365	103
Tiny		72						2,280	
Tisdale	177		1,050	110		1,800		3,069	
Togo		1,760				1,911		6,395	
Tuxford	302		974	1,778				1,842	155
Tyvan			1,976	2,028				875	

SCHEDULE No. 3.

STATEMENT OF GRAIN DISTRIBUTED AT RAILWAY STATIONS IN SASKATCHEWAN.

Station.	Wheat.				Oats.			Imported.	Barley.
	1 Nr.	2 Nr.	3 Nr.	No. 4.	1 Wh.	2 Wh.	3 Wh.		
Verigin				1,428				8,321	
Vonda		932	1,131					1,583	
Wadena	674		2,093	1,764				14,982	1,240
Walpole			655					805	
Wapella		4	1,576	1,209				1,212	241
Warman				145				696	
Watson	972	1,448	2,110	368		517		7,213	
Wauchope	1,048	1,030	2,010	1,000		1,909		2,383	
Wawota			300					325	
Welwyn			470					330	
Weyburn	1,002		4,215					2,843	
Whitewood		1,090	1,137	222		1,530		155	170
Windthorst	1,658		5,880	3,698		3,693		3,014	1,271
Wolseley			2,000	1,100		2,400		255	465
Yellow Grass	196	2,140	1,668			3,026		470	
Yorkton	398	1,362	2,212			30,711		9,520	902
Total	45,590	43,194	156,828	60,981	425	98,298	1,056	189,573	14,004

SCHEDULE No. 4.

STATEMENT OF GRAIN DISTRIBUTED AT RAILWAY STATIONS IN ALBERTA.

Airdrie			85					572	50
Alix			9			558		120	306
Bawlf		344	391			675	1,866	1,392	
Bassana						60			
Blackfalds			8			270			62
Bowden			289			1,920		1'645	351
Bow Island	60					110			
Bruderheim								115	
Calgary			44					2,709	378
Camrose		522				1,634		1,858	740
Canmore								251	
Cardston		55			116				
Carstairs			64					2,001	120
Cayley								1,822	
Chipman			8					120	14
Claresholm	470					265		25	
Cochrane			75			1,200		1,781	401
Coleridge	46					125			
Cowley		95				736			
Crossfield	100		65					700	160
Daysland	1,060	776				810		2,526	512
Didsbury			202			1,800		1,200	854
Edmonton			500					3,590	353
Fort Saskatchewan	524							4,832	748
Gleichen			30			85		100	
Grannum		120				1,690		12	
Grassy Lake	15					10			
Hardisty			522					3,201	200
High River		680				8,639		774	
Innisfail			680			8,466		149	1,789
Innisfree			1,122			1,800		267	258
Islay			1,122					4,000	461
Irvine	442					717		10	
Killam		306	710			582	1,200		180
Kitscoty			980					1,605	242
Lacombe			165			2,766		175	648
Lamont			304					2,702	404
Lavoy			154					1;507	145
Langdon						770		698	30
Leduc	178							11,591	1,188
Lloydminster								64	
Lougheed								28	
Lethbridge		72				208			
Manville			537	894				5,089	613
Medicine Hat		712						1,467	
Millet	180					1,399		1,330	
Midnapore								78	
Morinville			5,372					1,699	569
Morley								199	
Moringside			35			915		20	216
Mundare			280					1,132	111

SCHEDULE No. 4.

STATEMENT OF GRAIN DISTRIBUTED AT RAILWAY STATIONS IN SASKATCHEWAN.

Station.	Wheat.				Oats.			Imported.	Barley.
	1 Nr.	2 Nr.	3 Nr.	No. 4.	1 Wh.	2 Wh.	3 Wh.		
McLeod		430				160			
Nanton	250	100				2,858		475	
Ohaton		360				1,249		1,219	365
Okotoks		10				403		502	
Olds			199			1,842		4,388	660
Penhold			14					568	139
Ponoka		332				1,716	1,893	5,761	1,250
Pincher						380		10	
Ranfurley			105					455	20
Red Deer		700				1,906		3,354	668
Sedgewick		301				764		40	112
St. Albert			55					3,928	24
Sheppard						855			
Stavely	446					302			
Stettler		214	786					3,989	749
Stony Plain			313					1,240	156
Strathcona			128			677		3,865	1,086
Taber	129					174			
Strathmore			98			385			
Tees			28			1,768			185
Vegreville			936					4,746	517
Vermillion	1,000		1,626		345	1,458		8,922	1,742
Walsh	160					185			
Wetaskiwin	686				1,932	5,031	2,889	1,904	1,110
Total	5,746	6,099	17,984	894	2,393	60,323	7,848	110,522	20,886

SCHEDULE No. 5.

STATEMENT SHOWING TOTAL GRAIN DISTRIBUTED IN SASKATCHEWAN AND ALBERTA.

Saskatchewan	66,013	74,668	229,506	87,282	425	204,873	1,056	333,492	24,154
Alberta	5,746	6,099	17,984	894	2,393	60,323	7,848	110,522	20,886
Total	71,759	80,767	247,490	88,176	2,818	265,196	8,904	444,014	45,040

Total wheat	488,192
Total oats	720,932
Total barley	45,040
	1,254,164

REPORT OF THE SEED COMMISSIONER.

REPORT ON WORK OF SEED BRANCH IN CONNECTION WITH THE PURCHASE AND DISTRIBUTION OF GOVERNMENT SEED GRAIN.

Directly after the early frosts, which occurred in western Canada in the fall of 1907, steps were taken by the Seed Branch to ascertain the extent of the damage to the crop, and to collect all possible information as to which districts were so seriously affected as to require seed from outside points, and also the districts from which the necessary seed could be procured. The district officers located at Calgary, Regina and Winnipeg covered the three provinces as thoroughly as possible and collected samples of wheat, oats and barley, which were sent to our seed laboratories at Ottawa and Calgary, for germination test. A large number of samples were also secured direct from the farmers, and from the results of the germination tests of these samples, numbering about 2,500, much valuable information as to the actual condition of the crop was obtained. Results of the germination tests conducted up to January 10, together with information as to how the tests should be conducted and how the results should be interpreted, were published in bulletin form and 60,000 copies distributed throughout the west.

When the question arose as to the amount of seed that it would be necessary to purchase in order to supply the needy areas, the information compiled by the officers of the Seed Branch, together with that obtained from the results of our germination tests, was placed at the disposal of the governments interested. A calculation was made of the areas in the three provinces where seed wheat, oats and barley would have to be secured from outside sources. This estimate did not take into consideration the ability of the farmers to help themselves by procuring their own seed from distant districts.

WORK OF THE SEED BRANCH AS FIRST DEFINED.

The work of the Seed Branch, as defined by the Order in Council, covering the regulations respecting the purchase, sale and distribution of seed grain to homestead settlers in the provinces of Alberta and Saskatchewan, was confined to giving advice, when asked, as to the purchases outside Canada, and to making vitality tests of grain purchased in the west, or elsewhere, when such tests were considered necessary. The first eight sections of the Order in Council read as follows :—

1. All purchases of grain in Canada shall be made by the warehouse commissioner of the Department of Trade and Commerce, C. C. Castle, hereinafter called 'the purchasing agent,' and all purchases outside of Canada, shall be made by the purchasing agent under the advice, when it is practicable to obtain the same, of the seed commissioner of the Department of Agriculture, G. H. Clark.

2. Wheat shall be bought through the ordinary channels of the grain trade at current prices, from day to day at western receiving elevators, at Winnipeg, in transit to Fort William, at Fort William or elsewhere, subject to official grade and weight by proper officers of the grain inspection and weighing branch of the Department of Trade and Commerce; grades 1 and 2 Northern only shall be purchased if sufficient of these grades can be procured, but if not, No. 3 Northern may be purchased from receiving elevators or in transit at Winnipeg, but not in terminal elevators; grade No. 4 wheat may, if necessary, be purchased wherever it can be purchased, having due regard to its suitability for seed purposes, its grading and cleanliness, but should only be purchased in the event of there not being sufficient of the other grades procurable.

3. Oats shall be purchased through the ordinary channels of the grain trade at western receiving elevators, at Winnipeg, in transit to Fort William, at Fort William, or elsewhere, including eastern Canada, and shall be of grades Nos. 1, 2 and 3 white oats, as inspected and weighed by the Dominion Grain Inspection and Weighing officials, provided, however, should such purchases be made subject to a test as to vitality, a fixed advance on the market price from day to day may be arranged for by the purchasing agent at his discretion.

4. Barley shall be purchased as in the case of oats and wheat and may also be purchased in eastern Canada, and shall be of grades Nos. 2, 3 extra, and 3.

5. Where practicable grain may be purchased in car lots direct from farmers in Manitoba, Saskatchewan and Alberta at current prices from day to day, subject to official weight and grade.

6. All possible precaution shall be taken to have all seed purchased free from smut, noxious weed seeds and other varieties of grain, and with this object in view all such grain shall, if found necessary, be recleaned as thoroughly as possible at such warehouse cleaning plant as can be secured for this purpose.

7. Inspection, cleaning and recleaning shall be done under the direction of the purchasing agent by the grain inspector of the Department of Trade and Commerce, David Horn, assisted by such officers as may be appointed for the purpose by the governments of the provinces of Alberta and Saskatchewan, respectively.

8. The seed testing branch of the Dominion Department of Agriculture, under the direction of the seed commissioner, assisted by such officers as may be appointed for the purpose by the governments of the provinces of Alberta and Saskatchewan respectively, shall make tests for the purpose of ascertaining the vitality of all seed grain purchased in the west or elsewhere, whenever the same may be in the judgment of the seed commissioner necessary and practicable.

From the above it was clear that the work of the seed branch was defined in sections 1 and 8, and the responsibility of inspecting the grain offered for sale was to rest with the officers of the grain inspection and weighing branch of the Department of Trade and Commerce. With this division of work in mind, I wrote to Mr. C. C. Castle, purchasing agent, and Mr. E. D. Eddy, my district officer in Manitoba, on February 10, as follows:—

Mr. Charles C. Castle,
Warehouse Commissioner,
Winnipeg, Man.

Dear Mr. Castle,—I am to-day writing to my district officer at Winnipeg, Mr. E. D. Eddy, to call upon you and place himself at your disposal in the matter of conducting vitality tests of seed oats, barley or wheat. Mr. Eddy will make arrangements to have germination tests made in some greenhouse at Winnipeg, and you may expect to receive from him a report on the percentage germination at the end of five days, at least within a week, from the time you hand him the sample. Of course you would not be able to defer purchases for such germination report, but the records of such report may be useful before the seed be forwarded for distribution.

Seed oats that will germinate 50 per cent during the first five days should be counted as of satisfactory quality, considering the condition of the 1907 crop in the western provinces. Oats of the 1906 crop will germinate more than 90 per cent in five days. Those that will not germinate in five days under greenhouse conditions will scarcely be of much use when sown under field conditions, unless the soil is moist and the weather be exceptionally favourable.

Very truly yours,

(Signed) G. H. CLARK,
Seed Commissioner.

Mr. E. D. Eddy,
Edwards Block, Winnipeg, Man.

Dear Mr. Eddy,—I enclose herewith copy of letter sent to-day to Mr. Castle, Warehouse Commissioner, Winnipeg. Mr. Castle has been nominated chief officer in connection with the purchase of seed grain for the provinces of Saskatchewan and Alberta, and it is necessary that we give him all possible assistance that we can. I have no doubt that you have plenty of work on hand, but this work of Mr. Castle's must be attended to, and attended to very promptly. You will therefore at once place yourself at his disposal, as indicated in my letter, and receive samples from him twice daily, by calling at his office.

Without troubling Mr. Castle about the matter, you will, at our expense, make arrangements for having the oats tested in the soil for vitality. It would be most satisfactory if you could procure from some greenhouse convenient to your office enough space for conducting these germination tests. If you cannot get space in any greenhouse, you had better get a room, until April 1st, with windows having a south exposure, and heated so that the temperature will not fall below 55 degrees at any time, and be kept at an average temperature of not less than 65 degrees.

You will obtain definite agreement as to the cost of space in greenhouse or rent of room, in advance. If need be, you will have boxes for germination tests and trestles made on rush order for the work.

It is first of importance that there shall be no delay, and you will act throughout according to the instructions of Mr. Charles C. Castle.

I append herewith description of the boxes used in our Ottawa laboratory for soil tests, and the method of planting and counting, which I think you should follow throughout.

Faithfully yours,

(Signed) G. H. CLARK,
Seed Commissioner.

WORK OF INSPECTION ASSUMED.

On February 10th I received the following telegram from Mr. Eddy:—

'Warehouse Commissioner Castle starts buying seed grain here Wednesday and wants me to get authority to pass on it for purity and vitality. Wire instructions.'

On the morning of February 11th I received the following letter from Mr. David Horn, Chief Grain Inspector at Winnipeg:—

Mr. G. H. Clark,
Seed Commissioner,
Department of Agriculture, Ottawa.

Dear Sir,—Mr. Castle, Warehouse Commissioner, has been commissioned by the Department of the Interior to purchase seed grain for the needy farmers in Saskatchewan, Alberta, and, I presume, also Manitoba.

Mr. Castle seems to think that I will have to take the responsibility of passing upon and inspecting the seed he purchases. This it seems to me is practically the duty of your department, and, if not you, then the staffs of the experimental farms, or the two of you together. This morning I asked your Mr. Eddy to come in and see me and he informs me that he has no instructions of any kind. Mr. Castle is going on with his arrangements and will be purchasing largely immediately. My opinion is that you should at once see the Department of the Interior and arrange for your staff to be responsible for the accepting of what is deemed acceptable seed.

I am willing to co-operate as far as lies in my power and as far as is practicable in stating what the grade of such purchases is in the market, but it seems to me it is up to you to decide when it is good seed and in a fit state for sowing.

I hope you will see this in the same light as I do and that you will take action at once.

Yours truly,

(Signed) DAVID HORN,
Chief Inspector.

This made it clea that the Grain Inspection Branch at Winnipeg was not prepared to accept the responsibility of passing on the grain for seed purposes.

In conference with the Honourable the Minister of the Interior on the morning of February 11th, I was requested to provide a staff to do the inspection work; and I agreed to this, with the understanding that the provincial governments, who were the real purchasers, should set the standard of purity to which my inspectors should work. This was agreed to, and the following telegram was sent to Mr. Eddy:—

'You will provide Castle with written statement, showing probable vitality oats or barley. Also certificate purity all kinds. If samples will pass Seed Act without label, mark certificates accordingly. Retain all samples and copies of certificates. Wire if you need additional help.'

The following letters explain my position and the instructions given on this question:—

February 13, 1908.

To the Honourable the Minister of the Interior,
Ottawa.

RE INSPECTION OF SEED GRAIN PURCHASED BY C. C. CASTLE.

My understanding in conference in your office together with provincial representatives from Alberta and Saskatchewan *et al* was that all present agreed as to the inadvisability of purchasing and distributing seed grain contaminated with wild oats and other noxious impurities. Further, that the provincial representatives approved of Mr. Castle's suggestion to rely on the ruling of the Chief Grain Inspector at Winnipeg in the matter of grade, purity and vitality of seed wheat, oats and barley that might be inspected at that point.

On the night of February 10, I received a telegram from my district officer at Winnipeg, Mr. E. D. Eddy, and on the morning of the 11th a letter from Mr. David Horn, dated February 8th, which made clear to me that the Chief Grain Inspector respectfully declined to assume the responsibility in the matter of purity and vitality of the seed grain to be purchased by Mr. Castle. My previous instructions to Mr. Eddy have been to report to Mr. Castle twice daily and arrange to make actual vitality tests promptly, as required by Mr. Castle. My further instructions to Mr. Eddy, on the morning of February 11, were to at once assume responsibility in the matter of purity and vitality of seed, as per samples submitted by Mr. Castle, by furnishing Mr. Castle with a statement showing estimate of the percentage vitality of the grain, and the kinds, if any, and total number of noxious weed seeds per pound. On the morning of February 11, I also instructed my district officer for Saskatchewan to proceed at once to Winnipeg to Mr. Eddy's assistance, and on February 12 Mr. William Bond, expert seed analyst, was despatched from our Ottawa staff to Winnipeg. To augment our staff at Winnipeg, I have asked for and received consent from Mr. David Horn, Chief Inspector of Grain, for the loan of one or more of his trained men, should Mr. Castle need the additional assistance.

I take it that under the understanding and agreement, the provincial governments of Alberta and Saskatchewan have the right to dictate as to the quality of the seed grain that will be acceptable to them, and that it is not the privilege of the seed branch to do more than advise, inspect and certify as to such quality; also that Mr. Castle will keep himself informed, as the chief purchaser, as to what standard of purity will be satisfactory to the provincial authorities.

In the matter of any seed grain purchased by Mr. Castle east of Port Arthur, I shall, at his request, endeavour promptly to have lots inspected at points of shipment or elsewhere, as per his direction.

Yours truly,

(Sgd.) G. H. CLARK,
Seed Commissoiner.

Mr. E. D. Eddy,
Winnipeg, Man.

Dear Mr. Eddy,—I have taken the stand, and am supported by the honourable the Ministers of Agriculture and Interior, that it is the privilege and duty of the seed branch to advise as to the quality of the grain that may be purchased, but the acceptance of such grain is vested with the governments of Saskatchewan and Alberta. When they dictate as to the quality they want, Mr. Castle may name the quantity he may be able to supply, as per their requirements. They may be expected to amend their standard of quality from time to time. Mr. Castle will keep himself informed as to that.

Your certificates are intended for Mr. Castle's information only, and they should show your estimate of the percentage vitality, and the kinds and total number, or percentage by weight, of the various kinds of noxious weed seeds, including darnel in addition to those named in the Seed Control Act. Mr. Castle will make his own estimate as to what can be done by cleaning, and the provincial men will inspect and reject or accept at time of sacking.

From this letter I think you will understand the position in respect to responsibility that is to be assumed by the seed branch, and, in the meantime, you will have full authority over the operations of the seed branch at Winnipeg.

Faithfully yours,

(Signed) G. H. CLARK,
Seed Commissioner.

Mr. Castle evidently was under the impression that the seed branch had assumed the full responsibility of setting the standard for purity and passing on the grain submitted. This led to some confusion, as Mr. Eddy, the seed branch representative in Winnipeg, refused to O.K. samples that could not be cleaned to comply with the Seed Control Act. We adhered to the position that until the provincial governments expressed their willingness to accept a lower standard, we would have to stand by the standard of the Seed Control Act, which limits the impurities to one noxious weed seed per pound. The following letter from Mr. Castle indicates the difficulties of securing the required amount of grain in the limited time when the inspection was done under the Seed Control Act standard:—

Winnipeg, Man., February 18, 1908.

Geo. H. Clark,
Seed Commissioner,
Ottawa, Ont.

Dear Sir,—I reply to yours of the 15th inst., I think if you can arrange to leave Ottawa in about a week's time for Winnipeg it would be advisable for you to do so, as by that time everything here should be in full swing. I fear, however, that in the time available we shall be unable to secure either sufficient oats, wheat or barley to meet the requirements, as nothing but practically pure seed of any of these kinds of grain is being accepted. Of course my instructions by order in council are to purchase 1 and 2 Northern, and, if sufficient of these grades cannot be obtained, No. 3 west of Winnipeg and No. 4 wheat ; and as regards oats grades of 1, 2 and 3 white; and barley 2 and 3, but so far as selection of these grades is concerned I am acting entirely under Mr. Motherwell's recommendations, so that any car ruled out by your department will not be purchased. The wisdom of this rule can not be questioned, but there can be no doubt that with the limited time at our disposal the required quantities of seed will not be secured.

I am, sir, yours truly,

(Signed) CHARLES C. CASTLE,
Purchasing Agent.

In a report on the progress of inspection up to February 18, Mr. Eddy points out that of the number of cars of wheat and oats inspected by him, exceedingly few were accepted and O.K.'d as being sufficiently free from noxious weed seeds to be cleaned so as to conform with the provisions of the Seed Control Act.

Acting under the instructions quoted above, Mr. Eddy took the ground that, as the seed branch was responsible for passing on the grain, we had no right to accept seed badly contaminated with noxious weed seeds; and up to February 17, no approved certificates were issued on grain that could not be cleaned so as to conform to the Seed Control Act, as no intimation had been received from the provincial governments that they would accept a lower standard.

On the morning of February 17, Honourable W. R. Motherwell, commissioner of agriculture for Saskatchewan, arrived in Winnipeg, and the question of selecting a standard of purity was gone into. At that time it was apparent that sufficient grain could not be secured in time if the standard of inspection so far enforced were maintained, and Mr. Motherwell agreed to accept grain of a lower standard.

It was finally agreed that the standard of inspection for wheat should be no more than ten wild oats or ten purple cockle per pound, and for oats not more than twenty-five wild oats or twenty-five purple cockle per pound. Samples containing small weed seeds which could be removed by cleaning were not to be rejected, as the provincial representatives in charge of the cleaning plants had authority to have the grain cleaned as often as necessary in order to remove all small seeds. All samples containing even a trace of sow thistle, Canada thistle, ragweed or darnel were to be rejected. In all cases, the inspection for purity was made on official samples drawn under the direction of the chief inspector of grain, for the purpose of commercial grading.

While the seed branch representatives in Winnipeg were consulted in this matter and were, to some extent, responsible for fixing the standard of purity, they were merely acting in an advisory capacity.

Until February 17, arrangements were not completed with the railway companies for holding grain that was accepted, so that actual purchases from the trade did not start until that date. Duplicate certificates of all grain inspected on and after February 17 are now held in the seed branch offices.

PREMIUM PRICES RECOMMENDED FOR PURE SEED.

On Monday, February 24, I arrived in Winnipeg and spent the day examining the methods of inspection for purity and vitality. I was also accorded an interview with Mr. Charles C. Castle, at which the difficulties that were being experienced by him, in procuring supplies of seed wheat and oats that would comply with the standard of purity then adhered to, were discussed. The Honourable W. R. Motherwell arrived in Winnipeg on the morning of February 25, at which time the matter of inspection in relation to the standard of purity was fully discussed. With Mr. Motherwell's approval, I telephoned from the hotel to Mr. David Horn, chief inspector of grain, and asked him to meet us in conference, in order that we might get the benefit of his experience and advice. As a result of this conference, the following memorandum was drafted and presented to Mr. Castle for use as a basis for further discussion in conference with him :—

WINNIPEG, MAN., February 25, 1908.

Memo. for CHAS. C. CASTLE,
Seed grain purchasing agent,
Winnipeg, Man.

It would appear from the character of the supplies of seed grain offered up to date that if quality and purity of the seed is to be given proper and due consideration, then the price paid therefor must be quite secondary, and further, if the seed grain that appears to be required is to be obtained in seasonable time the supplies from the interior must come forward more rapidly than at present; or it will be adviasble to go to Fort William for a considerable portion of the wheat required.

In view of the foregoing, advice is given you as follows:—

Memo. of recommendations *re* procuring supplies of seed grain that may be acceptable to the farmers of the provinces of Saskatchewan and Alberta.

1. Make quality, especially in respect to weed seeds, the first consideration. The matter of price within reason for good clean seed grain should be of secondary consideration.

2. For seed grain, not the product of the Western provinces and which has not now ben accepted, adhere in the meantime to the provisions of the Seed Control Act in respect to purity.

3. For wheat, the product of the western provinces, allow not more than ten noxious weed seeds per pound, then reclean. Pay sufficient extra premium for what will pass Seed Act.

4. For oats, the product of the western provinces, allow not more than twenty-five noxious weed seeds per pound and then reclean. Pay small premium when they contain only ten wild oats or other noxious weed seeds per pound, and large and sufficient premium for oats that will pass Seed Act and is otherwise good seed.

5. Many portions of the province of Saskatchewan grow oats only for feed, and in view of the probable shortage of clean white oats, you are advised to purchase up to a quarter of a million bushels of Prince Edward Island black oats for the province of Saskatchewan.

6. Procure, say, five cars of oats out of several of the best bins at Fort William and have them sent to King's elevator to test result of his cleaning up to loss of fifteen per cent.

7. Arrange, if practicable and expedient, with the Canada Malting Company for the purchase of seed barley on commission, or otherwise as may be in your best judgment, subject to the conditions in respect to weed seeds as obtains for seed oats.

8. Suggest placing orders for Ontario and other eastern Canada oats and barley on commission basis with eastern Canada seedsmen, such as the Steele, Briggs Seed Company. Allow sufficient commission to induce prompt and aggressive action and allow good premium per bushel in advance over Toronto or other current market quotations for commercial grain—oats and barley clean for seed.

9. Restrict further British orders to named varieties and prevent as far as possible importations of potato oats; pay good premium for right good seed from Britain.

10. It is recognized that by continuing to adhere to this relatively high standard of purity, all of the demand for seed grain may not be supplied, but it is thought expedient at this time, and especially in view of past charges on the part of farmers in general against government importations of seed grain containing weed seeds, to purchase only and all that it is possible to get for them of relatively clean seed wheat, oats or barley.

Because of a large decrease in the estimated amount of oats required and the securing of more than at one time was thought available in the Old Country, the recommendations given in the latter part of paragraph 4 and paragraphs 5 and 6 in the above memorandum were not acted upon.

THE FINAL STANDARD OF PURITY.

Under instructions from the Hon. Mr. Motherwell and in accordance with announcement *re* premiums on purchase of wheat, the standard purity of wheat recommended in paragraph 3 was later altered, so that twenty purple cockle seeds per pound, instead of ten, were allowed. The standard of purity which the inspectors were instructed to follow on February 28th, and which was adhered to until the work was completed, was as follows:—

No sample of wheat to be accepted that contains any darnel, ragweed, Canada thistle, or perennial sow thistle, more than ten wild oats per pound, or more than twenty purple cockle per pound. Other noxious weed seeds not mentioned above may be allowed if cleaning plant is capable of removing them.

In addition to the above standard of cleanliness, the plumpness and fitness of the sample for seed must also be considered. Samples containing a large proportion of thin, lean or shrivelled kernels shall be rejected, as shall also be those which give evidence of containing different varieties.

Classification may be made as follows:—

Certificate to be marked A for samples entirely free from noxious weed seeds.

Certificate to be marked B for samples containing not more than one noxoius weed seed per pound.

Certificate to be marked C for samples containing not more than eight wild oats or purple cockle to the pound.

Certificate to be marked C for samples containing not more than five wild oats or purple cockle to the pound.

Certificate to be marked E for samples containing not more than ten wild oats or twenty purple cockle to the pound. Sample containing more than five wild oats must contain not more than ten cockle.

As aforementioned, the premium for oats, suggested in paragraph 4 of the memorandum submitted to Mr. Castle on February 25, was not offered, and our inspectors were instructed to adhere to the standard of 25 wild oats or 25 purple cockle per pound, or a combined count of 25, without classifying the accepted samples, as in the case of wheat.

RE PURCHASE OF BRITISH SEED OATS.

When the purchase of seed oats in Great Britain was decided upon, with the approval of the Honourable the Minister of Agriculture, I suggested to the Honourable the Minister of the Interior that if purchases were to be made based on inspection at British ports, Mr. A. W. Grindley, Chief Cargo Inspector of the Dominion Department of Agriculture, who is permanently located at Liverpool, might be appointed to make arrangements for that work of inspection. The suggestion was approved, and the following telegram was sent to Mr. Castle on February 14th:—

'Following draft of telegram prepared to be sent Strathcona. Please consider and amend or approve by wire to me: "Dominion, London—Matter purchase seed oats from Britain responsibility of inspection and issue certificate on kinds and quality ordered vested in Department Agriculture Department Interior through Charles C. Castle, Winnipeg, purpose placing orders with commission dealers subject inspection British ports. Castle will instruct *re* kinds and quality standard. Minister wishes you place inspection in hands A. W. Grindley who should procure services one suitable referee grain man and one expert seedsman to inspect and pass upon all shipments from Great Britain. (Sgd.) Agricult."

(Sgd.) F. OLIVER.'

Upon receipt of Mr. Castle's approval by wire, a cablegram, as drafted above, was sent to Lord Strathcona, Canadian High Commissioner, London. The arrangements made with Mr. Grindley are explained in the following extracts from a letter to the Honourable the Minister of Agriculture from Lord Strathcona, dated February 28th:—

'Immediately upon receipt of this message (the cablegram quoted above) I communicated with Mr. A. W. Grindley, by telegram, asking him to come to London to see me, which he accordingly did on the 21st inst., and I then went thoroughly into the matter with him. It was then arranged to appoint an expert to inspect the oats and for him to issue certificates covering quality as regards freedom from noxious weed seeds and wild oats; and also for the Corn Trade Associations of London and Liverpool to issue official certificates as to the natural weight of the various consignments of oats. Mr. W. B. McMaster, of Messrs. McMaster & Frankish, 15 Seething Lane, E.C., was appointed to issue certificates as to quality, such appointment being recommended by the London Corn Trade Association, who state Mr. McMaster to be well qualified to give certificates of the nature required. Similar arrangements have also been made in regard to Liverpool, where, in addition to the co-operation of the Liverpool Corn Trade Association, Mr. Grindley has appointed Mr. James Charnock, of the firm of Messrs. Joseph Pyke & Son, to inspect and issue certificates as to quality.

'These general arrangements having been made, Mr. Grindley can now carry out the necessary details in direct communication with your department, and I have notified him accordingly, informing him at the same time that I will gladly extend any further assistance possible, on hearing from him.'

Full instructions as to conditions of contract, &c., were forwarded to Lord Strathcona, and, later, direct to Mr. Grindley. The arrangements as to inspection outlined by Lord Strathcona were followed throughout the British shipments. Some of the certificates issued by the British inspectors might be said to be indefinite, insomuch that although the certificates made clear that the oats did not comply strictly with the terms of the contract, they did not state the proportion, nor, in some cases, the kinds of foreign seeds that were present.

It was made clear to the shippers by Mr. Grindley that if these lots were forwarded to Canada, they would have to be sent at the owner's risk, as they were not accepted by the inspectors. Under the direction of Mr. Castle, the cargoes containing these lots were reinspected in Canada. Most of them proved to be what is known in the trade as 'line grain;' that is to say, the amount of impurities were approximately equal to the margin of tolerance allowed under the Seed Control Act, which impurities were largely removed by the process of recleaning, to which all, or nearly all, the imported oats were submitted.

A few of the certificates indicated very clearly that parts of the shipments not only did not comply with the conditions of contract, but that they contained too many wild oats to be cleaned by practical process, to comply with the standard fixed for seed grain, except that purchased in western Canada. The reinspection of these lots at Winnipeg resulted in twelve car lots of the British oats being refused acceptance on account of the content of wild oats and other noxious weed seeds.

OFFICIALS EMPLOYED IN THE WORK OF INSPECTION.

The following permanent officials of the seed branch were authorized to inspect and issue certificates respecting the purity of the seed grain purchased in Canada, viz.:—

Messrs. Samuel J. Moore, official seed inspector for maritime provinces; T. G. Raynor, B.S.A., official seed inspector for the province of Ontario; E. D. Eddy, B.S.A., official seed inspector for the province of Manitoba; William Bond, assistant seed analyst of five years' experience; Harris McFayden, B.S.A., official seed inspector for the province of Saskatchewan; W. C. McKillican, B.S.A., official seed inspector for the province of Alberta; and James A. Hayes, assistant seed analyst in the Calgary laboratory. In addition, we had for a time the services of Mr. James Murray, superintendent, experimental farm, Brandon, Man., and, at my request, the chief inspector of grain allowed his deputy inspectors to issue certificates, on my responsibility, relative to the purity of seed grain purchased at Kingston and Toronto, in the province of Ontario, Regina and Moosejaw in Saskatchewan, Edmonton in Alberta.

ANALYSIS OF SAMPLE OF CARS SENT OUT.

As was previously mentioned, the cleaning operations were superintended by representatives for the provincial governments, who had authority to have the grain recleaned as often as necessary, in order to remove the small weed seeds and bring the grain to the highest possible standard of cleanliness before being sacked. It was also the duty of the provincial representatives to take representative samples of each car that was sent out. These samples were collected daily from the Winnipeg cleaning elevators and stored in the office of the chief grain inspector. When the work of cleaning was completed at Brandon, Moosejaw and Regina, samples of the cars sent out from these points were also sent to the office of the grain inspector at Winnipeg. An analysis was made of each of these samples by Seed Inspector E. D. Eddy, results of which are given below. It is assumed that the samples taken from the recleaned car lots by the persons in direct charge of the cleaning operations for the provincial governments were representative of the bulk of grain contained by the car.

SUMMARY ANALYSIS.

From the detailed report given below, it will be seen that of the 545 samples of wheat analyzed, nearly all representing full car lots, 149, or 27 per cent, were entirely free from noxious weeds mentioned in section 6 of the Seed Control Act; 167 lots, or 31 per cent, while not entirely free from noxious weeds, contained not more than one per pound, thus conforming to the provisions of the Seed Control Act; 165 lots, or 30 per cent, contained more than one noxious weed seed per pound, but not more than five, or about one twenty-fifth of one per cent; while 64 lots, or 12 per cent, contained more than five noxious weed seeds per pound. All of the seed wheat sent out had to be selected from commercial grain, but after cleaning 58 per cent of it was of such quality that it could have been sold as seedsmen's stock under the Seed Control Act.

Of the oats, those purchased in western Canada were by far the most badly contaminated with noxious weed seeds. Of the 201 lots analyzed, 16, or eight per cent, were free from the weed seeds mentioned in section 6 of the Seed Control Act; 16, or eight per cent, not entirely free from noxious weeds, contained not more than one per pound; 63 lots, or 32 per cent, contained over one noxious weed seed per pound, but not more than five; while 106 cars, or 52 per cent, contained over five noxious weed seeds per pound. With the exception of four cars, all of the oats supplied from Ontario conformed to the provisions of the Seed Control Act. Four wild oats per pound was the highest proportion of impurities shown in any of the Ontario oats cleaned at Winnipeg.

Of the 61 lots of Prince Edward Island oats examined, 47, or 77 per cent were entirely free from noxious weed seeds, while all the rest conformed to the Seed Control Act, with the exception of two cars, which contained a fraction over one wild oat per pound. The wild oats in the Prince Edward Island oats were of the smooth white variety.

Of the 200 samples of recleaned British oats examined, 56, or 28 per cent were entirely free from noxious weed seeds; 85, or 42½ per cent, contained not more than one wild oat per pound, while 59, or 29½ per cent, contained more than one wild oat per pound, but not more than five, the latter number being shown in only a few instances.

Of the 40 lots of barley analyzed, one was entirely free from noxious weed seeds, 13 containd not more than one per pound, 22 contained more than one but not over five per pound, while four contained more than five per pound, eight wild oats being the highest proportion of impurities shown.

During the process of recleaning, a few cars of seed grain were accidently mixed with oats badly contaminated with wild oats. This was made possible by the fact that some of the cleaning elevators could not be entirely given over to the cleaning of the government seed, and in handling their private business some badly contaminated oats were received into the elevators. The small quantity of these oats that was retained in the elevator bins and boots was sufficient to considerably affect the purity of the car of seed taken in immediately after the commercial oats were handled. As a result of this, two or three cars of wheat show a slightly higher number of wild oats per pound, after being cleaned, than was allowed by the standard of inspection. A few cars of oats cleaned at Winnipeg and Fort William were also affected in this way. In most of these cases, the mixed cars were detected and were not distributed for seed. The cars rejected in this way are starred in the list given below.

GERMINATION QUALITIES.

Actual germination tests of wheat and barley supplied were not considered necessary, as the vitality of these grains can be pretty accurately estimated by appearance. Samples containing any considerable proportion of thin or shrunken grains were rejected, even though they might grade high enough to be accepted.

The oats distributed direct from Ontario were not submitted to the germination test, as their vitality was considered unquestionable. In the case of the oats purchased at Edmonton, also, the germination test was not considered necessary, as the grain was all of the 1906 crop and quite free from injury. With the exception of the cases mentioned, the oats were put in for germination test as soon as purchased, and any that came below 70 per cent were reported to Mr. Castle as soon as the results were out. Mr. Castle found it impracticable to hold all the grain until the report of the germination test was available, and in some instances the cars were cleaned and sent out before the test was completed.

Further germination tests were made, as explained above, of the car samples as billed out after cleaning, and these results show that of a total of nearly 200 cars, purchased in western Canada, only twelve showed less than 70 per cent germination, while the average was between 85 per cent and 90 per cent.

The average percentage germination of the 127 cars of western oats, cleaned at the Winnipeg elevators, was 88 per cent. Four cars germinated 100 per cent, 66 cars 90 per cent and under 100 per cent, 38 cars 80 per cent and under 90 per cent, 12 cars 70 per cent and under 80 per cent, and 7 cars below 70 per cent.

The 29 cars cleaned at Brandon averaged 85 per cent germination. Eleven cars were over 90 per cent, eleven cars were over 80 per cent and under 90 per cent, three cars were over 70 per cent and under 80 per cent, and four cars were under 70 per cent.

The six cars cleaned at Regina averaged 85 per cent, the highest being 94 per cent and the lowest 81 per cent.

The 24 cars distributed from Calgary averaged 86 per cent. One car gave a germination of 100 per cent, nine cars were 90 per cent and under 100 per cent, eight cars were 80 per cent and under 90 per cent, five cars 70 per cent and under 80 per cent, and one car 66 per cent.

The seven cars of Ontario oats cleaned at Winnipeg averaged 95 per cent germination, the highest being 97 per cent and the lowest 91 per cent.

The 61 cars of Prince Edward Island oats cleaned at Winnipeg averaged 88 per cent, the highest being 100 per cent and the lowest 78 per cent. One car germinated 100 per cent, 25 cars 90 per cent and under 100 per cent, 33 cars 80 per cent and under 90 per cent, and two cars under 80 per cent.

The 133 cars of British oats cleaned at Winnipeg gave an average germination of 89 per cent, the highest being 99 per cent and the lowest 78 per cent. Fifty-nine cars were over 90 per cent, 73 cars were 80 per cent and under 90 per cent, and one car below 80 per cent.

The 31 cars of British oats from the *Empress of Ireland* shipment, cleaned at Fort William, averaged 92 per cent germination, the highest being 99 per cent and the lowest 84 per cent. Twenty-four cars germinated 90 per cent and over and seven cars 84 per cent and under 90 per cent.

The 32 cars of British oats from the *Empress of Britain* shipment, cleaned at Fort William, averaged 88 per cent germination, the highest being 100 per cent and the lowest 76 per cent.

In the following detailed report all cars that were sampled after cleaning at Winnipeg, Brandon, Regina, Moosejaw and Fort William, and the samples retained in the chief inspector's office at Winnipeg, are included. The cars that were rejected after being cleaned and those that were recalled after being sent out, according to the list provided by Mr. Castle, are starred. The list therefore includes any cars that may have been cleaned and sampled but were not required for seed. In the case of the Calgary grain, only those cars that were distributed are included. All grain that was accepted by the inspector at Edmonton is included.

GEO. H. CLARK,
Seed Inspector.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
42,000	500	2 Nor	1 wild oat	Odd wild buckwheat.
73,000	441	1 "	1 wild oat in 2 lbs.	" "
73,000	59	2 "	5 purple cockle, 2 cow cockle	" "
11,200	350		1 wild oat, 5 purple cockle, 1 cow cockle	A few tame oats.
44,200	111	No. 4	1 wild oat	Odd wild buckwheat.
44,200	378	3 Nor	2 wild oats	" "
15,300	350	No. 4	"	" "
54,500	525	1 Nor	1 p.c. in 2 lbs	Free.
41,400	500	1 "	15 purple cockle, 1 cow cockle	"
31,700	550	3 "	1 purple cockle in 2 lbs	Odd wild buckwheat.
32,800	510	1 "	1 wild oat, 1 cow cockle	" "
35,900	525	3 "	1 ball mustard in 2 lbs	" "
41,010	525	3 "	1 wild oat in 2 lbs	" "
43,110	500	No. 4	1 wild oat	" "
43,210	500	3 Nor	1 purple cockle	" "
49,210	327	3 "	1 w.o. in 2 lbs., 2 purple cockle	" "
49,210	173	1 "	2 w.o. 1 p.c., 1 c.c., 1 ball mustard in 2 lbs	" "
37,410	525	3 "	Free	Free.
510		2 "	1 p.c., 1 c.c. in 2 lbs	Odd wild buckwheat.
32,510	500	1 "	1 p.c., 1 c.c.	" "
36,610	480	No. 4	1 w.o., 1 p.c. in 2 lbs	" " and tame oat.
28,810	350	1 Nor	1 w.o., 1 ball mustard	Free.
40,910	558	3 "	Free	Odd wild buckwheat.
93,910	500	3 "	1 w.o., 1 p.c., in 2 lbs	" "
52,020	94	2 "	3 w.o., 2 cow cockle	" "
52,020	406	1 "	Free	" "
40,220	525	1 "	1 purple cockle, 1 cow cockle	Free.
71,220	525	2 "	1 p.c. in 2 lbs	Odd wild buckwheat.
40,420	550	1 "	1 w.o., 1 p.c.	" "
38,520	525	3 "	1 w.o.	" "
98,620	525	3 "	3 p.c. in 2 lbs	Occasional oat.
40,720	525	3 "	Free	Little wild buckwheat.
41,820	566	3 "	1 p.c. in 2 lbs	Odd wild buckwheat.
43,820	525	3 "	Free	" " and tame oat.
71,920	550	3 "	2 p.c.	Free.
37,130	525	3 "	1 w.o. in 2 lbs	Odd wild buckwheat and tame oat.
38,430	550	3 "	Free	Free.
36,630	488	3 "	"	Odd wild buckwheat.
36,630	12	No. 4	1 w.o. in 2 lbs	" " and bl'ck oat.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
37,630	525	3 Nor	1 w.o	Odd w. b. and w. sunflower.
41,730	148	1 "	1 w.o. in 2 lbs....	Occasional w. b. and vetch.
41,730	352	3 "	2 w.o	A little wild buckwheat.
75,730	415	3 "	3 p.c., 1 c.c. in 2 lbs........	Odd tame oat.
830	425	1 " ...	1 w.o., 1 p.c., 5 c.c........ ...	Free.
3,830	545	3 "	Free..........	Odd wild buckwheat.
147,930	500	2 "	1 w.o. in 2 lbs...........	" "
57,930	....	No. 4.....	Free..................... ..	Odd wild buckwheat and tame oat.
37,040	525	3 Nor	"	" " sunflower.
22,240	325	2 "	2 p.c. 2 cc...........	" " [illegible]
72,240	550	No. 4.......	1 w.o., 1 p.c....................	" " and tame oat.
31,340	525	3 Nor... ...	1 ball mustard	" " [illegible]
41,440	542	3 "	Free...	" " and tame oat.
34,440	508	No. 4.....	"	" " and bl'ck oat.
52,740	500	"	6 w.o., 1 p.c...	Considerable w.b.
47,740	500	3 Nor.... .	1 p.c. in 2 lbs...	Odd tame oat.
147,740	498	3 "	Free...	"
32,940	506	3 "	3 w.o...............	Odd w.b. and tame oat.
33,050	500	2 "	8 p.c., 2 c.c..........................	Odd w.b. and tame oat.
41,250*	424	No. 4	1 p.c. in 2 lbs..	Odd w.b. and black oat.
77,450	500	No. 4	1 c.c., 1 ball mustard........ ...	Considerable w.b.
40,550	500	....	3 w.o., 2 p.c., 1 c.c.............	Odd w.b. and tame oat.
43,650	525	3 Nor......	1 p.c..............	" " "
36,750	500	3 "	Free......	" " "
43,460	525	1 "	1 w.o., 1 c.c., 2 p.c. in 2 lbs	A few tame oats.
19,460	350	No. 4	1 w.o. in 2 lbs	Odd wild buckwheat.
78,660	500	3 Nor.....	1 p.c., 1 c.c....................	" tame oat.
43,760	525	3 "	1 w.o.	" "
45,760	107	2 "	1 p.c. in 2 lbs...................	" wild buckwheat.
45,760	393	3 " . .	1 w.o., 1 p.c., 1 c.c. in 2 lbs......	" " "
76,960	436	3 "	Free..........................	" w.b. and tame oat.
76,960	64	2 "	1 w.o., 1 p.c	Free.
30,270	350	No. 4 ...	1 c.c. in 2 lbs..	Little wild buckwheat.
40,370	500	3 Nor.......	1 w.o., 1 p.c. in 2 lbs...........	Odd wild buckwheat,
42,470	525	No. 4.... .	Free..........	" w.b. and tame oat.
38,570	525	3 Nor.......	1 p.c, 1 c.c........	" black oat.
39,570	525	3 "	Free..	A little wild buckwheat.
77,770*	315	3 "	1 p.c., 1 w.o. in 2 lbs	Odd w.b. and tame oat.
39,770	550	3 "	Free..	" wild buckwheat.
35,970	510	2 "	"	" w.b. and 1 darnel in 2 lbs.
33,080	492	2 "	1 c.c........	" wild buckwheat.
94,180	525	3 "	2 w.o., 1 p.c., 1 c.c., 1 ball mustard	" " "
25,480	350	1 "	2 w.o., 1 p.c....................	Free.
42,580	525	.. ..	1 w.o. in 2 lbs.	Odd wild buckwheat.
91,680	525	2 Nor.	2 w.o., 2 p.c., 1 ball mustard.....	" " "
34,880	550	3 "	1 w.o., 2 p.c	" " "
57,090	400	2 "	1 w.o., 4 p.c	" " "
48,490	525	....	1 p.c., 1 c.c...	" " "
74,690	525	1 Nor. ...	4 p.c., 3 c.c................ .	" w.b. and tame oat.
45,690	700	No. 4. ...	1 w.o.......	Free.
2,790	314	1 Nor......	1 w.o., 1 p.c., 5 c.c	Odd wild buckwheat.
2,790	186	3 "	Free.	" tame oat.
35,890	500	....	3 w.o., 3 p.c., 1 c.c. in 2 lbs . ..	" wild buckwheat.
45,890	427	2 Nor.. ...	2 p.c., 1 c.c...	" w.b. and tame oat.
45,890	89	1 "	2 w.c.	" wild buckweat.
2,990	522	3 "	Free..	" w.b. and tame oat.
20,002	250	1 "	6 p.c., 1 c.c., 1 w.o. in 2 lbs ...	A few tame oats.
42,002	525	2 "	1 w.o , 1 ball mustard.........	Free.
44,002	525	3 "	Free....	A little wild buckwheat.
38,202	500	3 "	2 c.c........	Free.
39,402	525	3 "	Free...	Odd w.b., tame oat.
302,502	500	2 "	2 p.c..........	" wild buckwheat.
91,602	100	No. 4.	1 p.c. in 2 lbs.......	" " "
91,602	450	3 Nor.....	2 w.o., 15 p.c., a little cow cockle.	" w.b. and tame oat.
13,602	343	3 "	Free..........	" wild buckwheat.

*41,250 This car also contains 101 sacks 3 Nor.
*77,770 This car also contains 67 sacks No. 4 and 3 sacks 2 Nor.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
40,702	525	2 Nor.	Free	Odd w.b. and black oat.
31,702	233	No. 4.	"	" " "
31,702	69	3 Nor.	1 w.o. in 2 lbs	" wild buckwheat.
31,702	198	2 "	1 w.o., 7 p.c., 4 c.c. in 2 lbs	" " "
39,802	525	3 "	1 w.o., 1 c.c. in 2 lbs	" " "
43,902		No. 4.	7 p.c., 1 w.o. in 2 lbs	" " "
54,902	550	3 Nor.	Free	" " "
36,512	500	3 "	1 w.o. in 2 lbs	" " "
37,512	525	No. 4.	" "	" " "
38,612	545	3 Nor.	Free	" w.b. and tame oat.
32,712	550	No. 4.	2 p.c	Free.
34,712	500		1 c.c. in 2 lbs	Odd w b., lambsquarters and tame oats.
74,812	500	1 Nor.	2 c.c., 2 ball mustard	" wild buckwheat.
92,022	537	2 "	1 w.o	" w.b. and tame oat.
43,112	525	3 "	Free	" wild buckwheat.
42,222	516	3 Nor	Free	Odd w.b. and tame oat.
14,222	350	No. 4.	"	" " "
43,322	525	" 4.	1 p c in 2 lbs	" wild buckwheat.
37,422	525	" 4.	1 w.o	" "
42,522	500	" 4.	1 w.o., 1 p.c., 1 c.c. in 2 lbs	" w.b. and tame oat.
39,622	525	No. 4.	1 w.o in 2 lbs	Odd w.b. and tame oat and a little smut.
39,722	525	3 Nor	1 p.c	Odd black oat.
57,822	550	3 "	1 w.c., 7 p.c. in 2 lbs	Odd tame oat.
145,922	600	3 "	1 w.o. in 2 lbs	Odd wild buckwheat.
39,922			Free	Considerable w.b., odd wild sunflower and tame oat.
74,032*	334	2 Nor	11 w.o	Odd w.b. and vetch.
40,232	525	3 "	2 w.o., 2 p.c	Odd w.b. and tame oat.
31,232	500	No. 4.	4 w.o., 2 p.c	" "
43,432	500	3 Nor	1 w.o. in 2 lbs	Odd wild buckwheat.
42,532	525	No. 4.	Free	Free.
73,832		3 Nor	1 w.o. in 2 lbs	Odd wild buckwheat.
91,932	525	2 "	1 w.o., 6 p.c., 4 c.c. in 2 lbs	" "
38,042	500	3 "	1 c.c. in 2 lbs	" "
52,142	502		Free	Odd w.b. and tame oat.
43,242	200	Sa.	2 p.c., 3 c.c., 1 ball mustard	A little w.b. and considerable mixture of oats.
43,242	300		5 p.c., 5 c.c	A little wild buckwheat.
48,342	500	1 Nor	1 w.o. in 2 lbs	Odd wild buckwheat.
58,342	233	1 "	1 w.o., 1 c.c. in 2 lbs	" "
58,342	267	2 "	2 w.o., 5 p.c., 5 c.c.	Free.
4,442		2 "	1 w.o., 7 p.c., 1 c.c	Odd vetch and barley grain.
52,642	500	2 "	Free	" wild buckwheat.
38,742	500	3 "	"	" "
40,842	525	3 "	1 w.o	Considerable w.b.
39,842	525	No. 4.	1 c.c., 1 p.c. in 2 lbs	Odd wild buckwheat.
91,942	517		1 w.o., 2 p.c., 1 c.c	A little wild buckwheat.
38,052		3 Nor	Free	Odd wild buckwheat.
49,152	350	No. 4.	"	" "
51,552	528	3 Nor	"	" w.b. and wild sunflower.
45,552	496	2 "	2 p.c., 1 c.c	A few tame oats.
142,852	618	3 "	4 p.c., 1 c.c	Odd w.b. and tame oat.
94,852	396	No. 4.	1 p.c., 4 c.c	" " "
47,852	356	1 Nor	5 p.c., 1 c.c	Free.
47,852	144	3 "	1 w.o., 10 p.c. in 2 lbs also some cow cockle	Odd wild buckwheat.
15,952	350	1 "	1 w.o. in 2 lbs	" "
32,952	538	2 "	1 w.o., a little hare's-ear mustard.	" "
37,952	525	No. 4.	2 w.o.	" "
31,062	547	3 Nor	2 w.o	" "
146,062	700	3 "	Free	" "
57,162	525	No. 4.	1 w.o	" "
4,162	499	3 Nor	Free	" "

*74,032. This car was not distributed.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds Mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
35,162	500	No. 4.	2 w.o., 9 p.c	Odd w.b. and tame oat.
36,362	541	3 Nor	1 p.c. in 2 lbs	" wild buckwheat.
18,362	344	3 "	6 p.c., 2 c.c,	Free.
1,462*	514	....	2 p.c	"
94,462	550	3 Nor	1 w.o., 4 p.c	A few tame oats.
3,862	500	2 "	1 w.o	Odd wild buckwheat.
57,862	350	3 "	1 w.o., 1 p.c. in 2 lbs	" tame oat.
90,962	550	3 "	3 w.o., a little w.b	A little wild buckwheat.
39,172	492	1 "	2 p.c., 3 c.c	Odd wild buckwheat.
58,272	550	No. 4.	1 w.o., 1 p.c., 2 c.c. in 2 lbs	" "
3,372	500	3 Nor	1 w.o., 2 p.c. in 2 lbs	" "
55,372	525	No. 4.	1 p.c. in 2 lbs	" "
26,372	350	3 Nor	1 p.c., 1 c.c. in 2 lbs	" "
36,372	500	1 "	6 p.c., 2 c.c	" w.b. and tame oat.
38,872	550	No. 4.	1 w.o., 4 p.c	Free.
15,972	350	3 Nor	1 p.c. in 2 lbs	1 black oat in 2 lbs.
59,972	525	2 "	Free	1 w.b. per lb.
48,082	500	No. 4.	3 w.o., 2 p.c., 1 c.c	Considerable w.b.
59,182	520	2 Nor.	1 w.o., 7 p.c., 3 c.c	Odd w. b. and tame oat.
27,282	....	No. 4.	1 w.o	Odd lambsquarter and tame oats.
71,382	500	2 Nor.	1 w.o., 2 p.c., 2 c.c.	Odd wild buckwheat.
41,482	500	3 "	1 c.c in 2 lbs	Some wild buckwheat.
91,582	500	3 "	1 ball mustard in 2 lbs	Odd wild buckwheat.
41,782	525	3 "	1 w.o., 1 c.c. in 2 lbs	Odd w.b. and tame oats.
38,882	500	1 "	1 w.o. in 2 lbs	Odd wild buckwheat.
38,882	525	3 "	1 w.o., 2 p.c., 1 c.c	" "
71,092	500	3 "	Free	Odd w.b. and tame oat.
*33,492	197	3 "	1 w.o. in 2 lbs	Odd wild buckwheat.
40,692	525	1 "	1 w.o., 3 c.c. in 2 lbs	" "
41.692	333	No. 4.	1 w.o., 1 ball m. in 2 lbs	Occasional wild buck.
41,692	167	1 Nor	2 w.o., 1 p.c	Odd wild buckwheat.
27,792	....	2 "	1 w.o. in 2 lbs	" "
37,792 C.P.R.	525	No. 4.	1 p.c. in 2 lbs	" "
37,792 C.N.R.	525	3 Nor.	1 w.o., 3 p.c. in 2 lbs	" "
892	515	3 "	1 w.o. in 2 lbs	" "
57,992	352	1 "	1 p.c	" "
57,992	148	3 "	Free	" "
3,263	520	2 "	3 p.c., 3 c.c	" "
44,104	534	3 "	Free	Odd w.b. and tame oat.
4,404	477	3 "	Free	Odd wild buckwheat.
26,404	350	2 "	2 w.o., 4 p.c., a little c.c.	" "
41,504	....	No. 4	Free	Odd w.b., oats and flax.
42,604	500	3 Nor.	3 w.o., 2 p.c., 1 c.c	Free.
91,704	550	No. 4	1 w.o	Odd wild buckwheat.
71,804	500	2 Nor.	2 w.o., 3 p.c	" "
39,904	525	1 "	1 c.c. in 2 lbs	Odd w.b. and vetch.
48,014	525	3 "	2 w.o., 1 p.c., 1 c.c. in 2 lbs	Odd w.b. and tame oat.
17,114	250	No. 4	1 w.o., 1 p.c. in 2 lbs	Odd wild buckwheat.
51,514	500	3 Nor.	1 w.o., 2 p.c., 6 c.c. in 2 lbs	Free.
41,614	525	3 "	2 w.o., 1 p.c	Odd wild buckwheat.
350,614	350	1 "	1 w.o. in 2 lbs	" "
1,714	500	3 "	1 p.c , 1 c.c. in 2 lbs	" "
43,814	500	3 "	Free	" "
24,914	350	1 "	3 w.o., 1 p.c. in 2 lbs	" "
39,024	....	....	1 w.o., 1 p.c	Odd w.b. and tame oat.
43,224	500	3 "	1 w.o., 7 p.c	Odd tame oat.
36,224	500	2 "	3 w.o., 3 p.c	Odd wild buckwheat.
26,324	163	2 "	2 p.c., 1 c.c.	Free.
26,324	162	3 "	1 w.o., 1 p.c., 4 c.c	Free.
78,324	525	3 "	1 w.o., 2 p.c. in 2 lbs	Odd wild buckwheat.
93,424	....	3 "	1 c.c. in 2 lbs	Free.
25,424	350	3 "	Free	Odd wild buckwheat and tame oat.
73,624	525	1 "	1 w.o., 2 p.c	Odd vetch and tame oat.
144,824	702	No. 4.	Free	Odd w.b. and black oat.

*33,492, Balance of this car loaded with 2 Nor. wheat.
*1,462. This car was not distributed.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
147,924	500	2 Nor.	1 w.o., 1 p.c.	Odd wild buckwheat.
56,034	500	No. 4.	1 w.o., 10 p.c., 3 c.c.	" "
72,234	529	3 Nor.	1 c.c. in 2 lbs.	Odd w.b. and tame oats.
43,234	500	1 "	1 w.o. in 2 lbs	Odd wild buckwheat.
*43,834	381	No. 4.	2 p.c., 1 c.c.	" "
25,044	350	1 "	1 w.o., 3 c.c.	" "
43,244	525	3 "	1 w.o., 1 p.c.	" "
55,244	544	3 "	Free	" "
48,344	500	2 "	1 w.o.	" "
39,344	525	3 "	1 p.c. in 2 lbs.	Odd tame oats.
36,744	528	3 "	1 w.o. in 2 lbs	Free.
38,844	525	3 "	1 w.o. in 2 lbs	Free.
35,944	525	3 "	Free	Odd w.b. and tame oats.
554	....	3 "	Free	Odd wild buckwheat.
42,654	478	2 "	1 w.o., 2 p.c., 1 c.c., 1 ball m.	Free.
43,754	....	3 Nor.	1 w.o. in 2 lbs	Odd wild buckwheat.
38,754	473	1 "	1 w.o.	" tame oat.
43,854	525	3 "	3 p.c., 1 p.c.	" wild buckwheat.
42,954	320	3 "	Free	" " "
42,954	180	1 "	1 w.o., 1 c.c., 5 p.c. in 2 lbs.	" " "
40,164	525	3 "	Free	" w.b. and tame oats.
144,164	600	3 "	1 p.c.	" " " "
36,264	543	3 "	2 p.c., 1 c.c.	" "
75,364	439	1 "	Free	" "
40,464	550	No. 4	"	" "
302,464	500	2 Nor.	1 w.o., 7 p.c., 1 c.c.	" "
19,464	350	3 "	2 p.c and considerable c.c	" "
29,564	325	2 "	2 w.o., 5 p.c., 5 c.c.	" "
58,864	440	3 "	Free	" "
58,864	60	1 "	"	" "
42,674	....	3 "	"	" "
39,674	525	3 "	"	" " and black oats.
46,774	534	3 "	"	" "
92,874	525	1 "	1 w.o., 5 ball mustard in 2 lbs.	" tame oats.
94,874	539	3 "	1 c.c. in 2 lbs	" w.b. and tame oats.
2,974	509	3 "	Free	" " " "
40,080	....	No. 4	"	" "
44,284	500	....	"	" "
9,284	....	3 Nor.	1 wild mustard	Free.
44,384	530	2 "	Free	Odd w.b.
52,684	550	No. 4	1 w.o., 3 p.c	" " and tame oats.
34,684	....	No. 4	Free	" "
38,784	500	No. 4	"	" " and tame oats.
39,984	523	3 Nor.	1 c.c. in 2 lbs.	" " " black oats.
71,094	550	No. 4	1 w.o., 1 c.c. in 2 lbs	" "
33,094	351	3 Nor.	1 p.c. in 2 lbs.	" "
33,094	149	No. 4	Free	" "
44,094	525	1 Nor.	"	" " and vetch.
43,394	525	2 "	1 w.o. in 2 lbs	" grain of barley.
76,694	525	3 "	1 c.c. in 2 lbs.	" w.b. and tame oats.
38,894	525	1 "	2 w.o., 2 p.c., 1 ball mustard	" "
78,894	....	3 "	7 w.o., 12 p.c., 1 c.c., 1 hare's-ear mustard	" " and tame oats.
78,894	....	....	2 w.o., 1 p.c., 3 c.c.	" " " "
42,994	525	3 "	Free	" " " "
92,106	525	No. 4	"	" " " black oats.
40,206	525	3 Nor.	"	" "
72,206	550	3 "	5 p.c.	" tame oat.
43,206	536	3 "	Free	" w.b. and tame oats.
40,306	214	3 "	"	" "
40,306	286	2 "	1 w.o., 1 p.c. in 2 lbs.	" "
44,306	525	3 "	1 p.c. in 2 lbs	" vetch and tame oats.
72,406	525	3 "	1 w.o.	" w.b.
98,606	525	2 "	2 p.c., 1 c.c.	" tame oat.
2,706	525	No. 4	1 w.o.	" " "

*43,834, The balance of this is loaded with 2 Northern wheat.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
74,706	517	3 Nor.	Free	Odd w.b. and tame oat.
26,806	350	3 "	3 w.o., 6 p.c. in 2 lbs	" " " "
74,016	151	1 "	Free	" " 1 darnel in 2 lbs.
74,016	374	No. 4	1 w.o. in 2 lbs	Free.
24,216	250	1 Nor.	1 w.o	Odd w.b.
24,216	100	3 "	3 w.o. in 2 lbs	" tame oat.
37,216	55	No. 4	Free	" w.b. and tame oats.
37,216	415	1 Nor.	1 w.o	" "
146,416	434	1 "	Free	" "
43,516	553	3 "	"	" " and tame oats.
142,916	111	3 "	"	" "
142,916	489	2 "	3 w.o., 1 p.c.	" "
41,916	506	1 "	Free	" "
38,026	526	3 "	"	" " and black oats.
410,126	540	3 "	"	" "
40,226	525	3 "	1 c.c. in 2 lbs	" "
24,226	350	1 "	1 w.o., 1 p.c.	" "
25,226	350	....	2 p.c., 1 c	" " and tame oats.
72,426	525	3 "	1 p.c., 1 w.o., 1 c.c. in 2 lbs	" " " "
147,426	700	No. 4	1 w.o. in 2 lbs	Free.
78,526	544	1 Nor.	1 " "	Odd w.b.
43,626	535	1 "	Free	" "
4,136	525	3 "	"	Odd tame oats.
58,336	525	1 "	1 w.o. in 2 lbs	Odd w.b.
36,736	525	3 "	1 w.o	" "
37,736	525	1 "	1 "	" "
58,936	204	3 "	2 p.c., 2 c.c.	" "
58,936	296	2 "	1 w.o., 2 p.c., 4 c.c	" "
36,046	500	3 "	6 p.c., 7 c.c	" " and tame oat.
40,146	500	3 "	1 p.c., 5 c.c	" "
94,146	550	3 "	1 wo., 3 p.c., 1 c.c	" " " "
42,246	525	3 "	Free	"
24,246	350	3 "	1 w.o. in 2 lbs	" " and black oat.
37,446	525	No. 4	Free	"
75,646	558	1 Nor.	"	"
38,646	500	1 "	9 p.c., 8 c.c., 1 w.o	"
37,746	525	3 "	1 w.o. in 2 lbs	"
140,846	500	3 "	Free	Odd tame oat.
46,846	513	3 "	4 p.c., 6 c.c	" w.b.
41,056	....	2 "	3 p.c	" tame oat.
147,256	700	2 "	2 w.o	" w.b.
2,356	525	1 "	1 p.c., 1 c.c	" "
40,456	500	3 "	Free	" "
90,456	....	2 "	3 p.c	" " and tame oat.
43,456	525	3 "	3 p.c., 1 c.c	" "
36,456	500	1 "	1 c.c. in 2 lb	" "
46,456	525	2 "	1 w.o., 3 p.c., 1 c.c. in 2 lbs	Free.
41,556	525	3 "	1 w.o., 3 p.c., 4 c.c., ball mustard.	"
46,556	525	3 "	1 w.o., 4 c.c., 2 ball mustard	Odd w.b.
37,556	538	No. 4	1 p.c	" "
57,556	500	2 Nor.	1 w.o., 5 p.c., 6 c.c. in 2 lbs	" "
43,756	500	No. 4	1 w.o	" "
13,856	350	3 Nor.	1 ball mustard in 2 lbs.	" "
144,856	600	3 "	3 w.o., 1 p.c., 2 c.c. in 2 lbs	" "
77,856	525	3 "	Free	" " tame oat.
147,266	550	3 "	1 w.o., 5 c.c. in 2 lbs	Free.
41,466	429	2 "	1 w.o., 4 p.c., 5 c.c. in 2 lbs.	Odd w.b.
41,466	71	No. 4	Free	" " and tame oat.
44,466	540	3 Nor.	"	" "
92,766	466	3 "	7 p.c., 5 c.c.	" "
141,866	600	1 "	1 p.c	" black oat.
36,866	500	3 "	Free	" w.b. and tame oat.
37,966	505	3 "	"	" "
41,176	479	2 "	1 w.o. in 2 lbs	" " and black oats.
41,176	46	3 "	4 w.o, 1 p.c., 1 c.c., 1 ball mustard.	" "
42,276	525	3 "	1 w.o., 1 p.c. in 2 lbs	" "
94,276	525	3 "	Free	" "

Recleaned Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
72,376	517	3 Nor.	1 w.o., 1 c.c. in 2 lbs	Odd b.w.
144,576	329	1 "	1 w.o., 3 p.c., 1 c.c	" "
144,576	171	3 "	3 w.o	" "
4,876	350	3 "	1 w.o., 10 p.c. in 2 lbs	Free.
12,976	....	3 "	3 w.o., 2 p.c	"
76,976	509	2 "	Free	Odd w.b. and tame oats.
20,086	220	No. 4.	1 w.o. in 2 lbs	" "
20,086	153	1 Nor	1 p.c., 1 c.c	" "
41,186	500	No. 4.	Free	" " and tame oat.
4,386	525	3 Nor	"	" "
37,486	525	No. 4	1 w.o	" "
2,586	372	1 Nor	1 p.c., 3 c.c. in 2 lbs	" tame oat.
2,586	128	2 "	1 w.o., 4 p.c., 3 c.c. in 2 lbs	" w.b.
41,786	542	2 "	1 w.o	" tame oat and barley.
47,786	550	No. 4	Free	" lambs quarters.
34,886	521	3 Nor.	"	" w.b.
92,096	500	No. 4	"	" "
71,196	525	3 Nor	1 c.c. in 2 lbs	" " and tame oats.
41,196	415	1 Nor	Free	Free.
93,196	544	2 "	4 p.c., 1 c.c.	Odd w.b. and tame oats.
55,296	512	2 "	9 p.c	" "
37,596	526	2 "	1 w.o., 1 c.c. in 2 lbs	" vetch.
57,596	501	1 "	1 w.o. in 2 lbs	" "
38,596*	....	2 "	4 p.c., 1 c.c	Considerable mixture white oat.
39,596	440	3 "	1 w.o., 5 p.c. in 2 lbs	Odd w.b.
39,596	60	No. 4	1 w.o. in 2 lbs	"
347,696	....	3 Nor	Free	" and black cat.
42,796	340	3 "	"	" "
53,796	....	3 "	1 p.c. in 2 lbs	" "
42,896	500	3 "	1 w.o. in 2 lbs	" tame oat.
38,896	500	No. 4.	Free	" w.b.
25,996	....	2 Nor	4 w.o	" "
90,008	500	2 "	Free	" "
40,508	525	No. 4	"	" " and tame oat.
39,608	550	1 Nor	1 w.o. in 2 lbs.	" " tame oat and barley.
40,708	500	3 "	2 p.c., 1 c.c	" w.b.
76,808	525	1 "	1 w.o. in 2 lbs	" "
144,908	426	2 "	1 w.o., 1 p.c., 1 c.c	" "
144,908	74	1 "	1 w.o., 1 p.c., 2 c.c. in 2 lbs	" "
38,908	447	No. 4	1 w.o. in 2 lbs	" " and black oat.
38,908	53	3 Nor	Free	" " "
147,218	393	3 "	"	" "
147,218	107	2 "	3 w.o. in 2 lbs	" "
34,518	555	3 "	1 w.o., 1 p.c	" "
44,518	525	1 "	1 w.o., 2 p.c., 3 c.c. in 2 lbs	" tame oat.
39,518	500	....	1 p.c., 1 c.c	" w.b.
43,618	525	1 "	2 w.o., 1 p.c., 3 c.c. in 2 lbs	Free.
36,818	525	3 "	1 w.o., 1 p.c. in 2 lbs	Odd w.b., sunflower and tame oat.
145,028	600	3 "	2 p.c	Odd w.b.
36,028	525	2 "	3 p.c., 4 c.c	" "
38,328	525	3 "	1 w.o., 3 p.c., 1 c.c. in 2 lbs	" "
3,428	500	1 "	1 p.c., 1 c.c	" "
36,728	500	3 "	1 c.c., 1 p.c. in 2 lbs	" tame oat
44,828	500	3 "	2 p.c., 2 c.c.	" w.b.
54,828	506	1 Hard	Free.	Free.
93,928	370	2 Nor	5 w.o	Odd w.b. and vetch.
93,928	180	3 "	Free	Free.
43,038	525	3 "	"	Odd w.b.
59,138	550	No. 4	1 w.o. in 2 lbs	" tame oat.
13,238	325	2 Nor	2 w.o., 5 p.c	" "
56,338	500	1 "	1 w.o., 1 p.c., 1 ball mustard 2 lbs.	" w.b.
44,538	525	1 "	1 w.o., 1 c.c	" "
37,638	525	No. 4	1 w.o. in 2 lbs.	" "
38,638	530	....	1 ball mustard	" " and tame oat.
39,638	350	3 Nor	Free	" "

† 38,596. This car was mixed with oats in the process of cleaning and was not distributed for seed.

RECLEANED Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and Number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
36,738	500	1 Nor......	1 w.o., 4 c.c. in 2 lbs	Odd w.b.
59,938	228	No. 4.......	Free..........	" "
59,938	297	3 Nor	"	" "
2,048	500	3 "	1 w.o	" "
55,048	550	....	Free..........	" " and tame oat.
22,148	303	No. 4.......	1 p.c., 1 c.c..........	" "
55,248	500	1 Nor... ...	1 p.c. 1 ball mustard..........	" "
37,348	....	3 "	1 p.c..	" "
50,448	539	2 "	3 w.o..........	" "
58,448	500	3 "	15 p.c., 1 c.c..........	" " and tame oat.
76,548	525	3 "	1 c.c..........	" " "
1,648	525	No. 4.......	Free.	" " and black oat.
47,648	525	1 Nor	"	Free.
57,648*	504	No. 4.......	16 w.o., 2 p.c., 2 c.c, 2 hare's-ear mustard.	Badly mixed with oats.
18,648	350	No. 4......	Free..........	Odd w.b. and black oats.
42,748	500	No. 4.	1 w.o. in 2 lbs..........	" and tame oats.
144,748	700	3 Nor. ...	2 w.o., 3 p.c..........	"
40,848	500	2 "	2 w.o., 9 p.c. in 2 lbs..........	"
48,918	500	3 "	4 p.c., 2 c.c..........	"
36,058	500	3 " ...	3 w.o..........	"
146,058	360	No. 4... ...	4 p.c	" "
146,058	340	3 Nor.......	4 p.c..........	"
38,158	525	3 "	1 hare's-ear mustard, considerable c.c..........	Free.
57,258	....	2 " ...	6 p.c., 6 c.c., 2 hare's-ear mustard	Considerable w.b.
41,358	521	2 "	1 p.c..........	Odd w.b. and tame oat.
32,358	547	3 "	Free	" "
4,358	512	2 "	1 w.o., 7 p.c. in 2 lbs..........	Odd tame oats.
39,358	495	3 "	Free..........	Odd w.b.
71,458	425	3 "	1 p.c..........	" tame oat and barley.
658	525	3 "	2 p.c., 1 c.c..........	"
40,068	525	3 "	1 w.o., 3 c.c..........	"
41,068	500	3 "	1 w.o. in 2 lbs	"
59,068*	300	3 "	Free..........	" and tame oat.
37,168	525	2 "	4 p.c., 1 c.c..........	Free.
39,268	500	3 "	Free	Odd w.b.
1,368	370	3 "	"	" and tame oat.
1,368	130	1 "	"	"
75,368	525	1 "	10 p.c., 3 c.c	" "
147,568	681	2 "	3 p.c., 5 c.c..........	"
42,868	205	No. 4. ..	Free..........	" "
42,868	295	3 Nor.	2 p.c	" "
72,868	....	3 "	Free..........	"
37,868	525	3 "	1 p.c., 1 w.o. in 2 lbs..........	Odd tame oat.
147,868	301	3 "	1 c.c. in 2 lbs	Odd w.b. and black oats.
147,868	199	1 "	1 w.o., 1 p.c., 4 c.c. in 2 lbs.....	"
42,078	500	No. 4.......	1 w.o., 1 c.c. in 2 lbs..........	" and tame oats.
58,078	500	3 Nor.....	10 p.c., 1 c.c..........	Odd tame oats.
39,078	491	3 "	1 w.o., 1 p.c., 4 c.c	Odd w.b.
54,178	525	1 "	1 w.o., 4 p.c., 1 ball mustard in 2 lbs	" and tame oats.
31,278	....	....	5 w.o., 1 ball mustard	" lambsquarters and tame oats.
42,278	500	No, 4.	Free..........	Odd w.b. tame oats and barley.
15,278	350	3 Nor.	1 w.o., 1 c.c., 2 ball mustard.....	"
36,378	550	No. 4.......	3 w.o., 2 p.c..........	"
45,478	532	3 Nor.	Free..........	" and tame oats.
43,578	550	3 "	5 p.c., 1 c.c., 1 w.o. in 2 lbs.....	Odd tame oats.
43,678	500	No. 4.......	3 w.o..........	Odd w.b.
37,678	525	3 Nor.......	Free..........	"
44,778	....	3 "	1 w.o. in 2 lbs..........	"
39,778	525	3 "	1 w.o., 1 p.c. in 2 lbs	"
39,878	198	No. 4.......	Free..........	" and tame oat.

* 57,648. This car was mixed with oats in the cleaning elevator, which accounts for the large amount of impurities.

* 59,068, balance of this car loaded with oats.

Recleaned Wheat Sampled at Winnipeg Cleaning Elevators.—*Continued.*

Car Number.	Number of two bushel sacks in car.	Grade.	Kinds and Number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not Mentioned in Section 6 of Seed Control Act.
39,878	97	3 Nor......	Free..........	Free.
39,878	205	1 "	1 w.o. in 2 lbs......	"
38,188	506	2 Nor.......	1 w.o. in 2 lbs....................	Odd tame oats and vetch.
38,288	526	No. 4.	2 p.c..........................	Odd w.b. and tame oats.
58,488	500	3 Nor.....	1 w.o., 1 p.c., 1 c.c	" 1 darnel in 2 lbs.
40,788	525	1 "	5 p.c.. 1 c.c..	Free.
38,888	510	3 "	Free..........................	Odd w.b. and black oats.
37,988	500	3 "	1 w.o	"
73,198	434	2 "	1 w.o., 5 p.c., 3 c.c...	"
146,398	650	No. 4. ...	3 p.c., 1 c.c	"
77,398	525	1 Nor......	1 w.o. in 2 lbs............. ..	"
42,498	550	3 "	1 w.o. in 2 lbs................ ...	Odd tame oats.
16,498	325	2 "	3 p.c., 1 c.c................	"
36,598	534	3 "	1 w.o.	"
25,698	177	3 "	2 c.c.......	"
25,698	173	1 " .. .	3 p.c., 1 c.o.....................	"
22,798	350	No. 4. ...	1 c.c.....	Odd w.b.
78,798	481	2 Nor ..	1 w.o., 3 p.c., 3 c.c.............	" tame oat.
39,788	545	3 " .. .	Free.........	" w.b.
42,998	499	1 "	1 w.o., 1 p.c, 2 ball mustard in 2 lbs	" "

Wheat Cleaned and Shipped from Regina.

55,920	556	No. 4.	3 p.c. in 2 lbs................ ...	Odd tame oat.
47,550	508	3 Nor	Free	" w.b.
90,732	558	3 "	Free	" " and tame oat.
38,142	537	No. 4.	1 wild mustard.................	" lambsquarters.
43,752	536	3 Nor	Free	" w.b. and tame oat.
47,752	528	3 "	Free	" "
55,852	480	3 " .. .	Free	" " and tame oat.
54,184	499	3 "	Free	" "
10,925	494	3 "	Free	" "
52,026	500	No. 4......	1 w.o. in 2 lbs	" "
39,926	511	No. 4.....	Free	" " and tame oat.
55,996	517	3 Nor	1 c.c. in 2 lbs	" "
77,796	490	3 "	Free	" " and tame oat.
75,818	525	3 "	1 c.c. in 2 lbs	Free.

Wheat Cleaned and Shipped from Moosejaw.

59,320	510	No. 4.......	3 p.c	Odd w.b.
42,802	504	No. 4.... ..	1 p.c	" "
15,732	327	2 Nor	4 c.c., 1 p.c........	" "
144,542	510	3 "	1 p.c., 4 c.c. in 2 lbs.......	" and tame oat.
71,672	440	3 "	1 w.o., 1 c.c. in 2 lbs	Free.
91,482	500	3 "	3 p.c., 1 c.c. in 2 lbs.	Free.
32,792	500	3 "	1 w.o., 1 p.c., 2 c.c. in 2 lbs......	Odd tame oat.
56,414	542	....	17 p.c., 3 c.c., 1 hare's-ear mustard	" w.b.
39,134	510	3 Nor	1 p.c. in 2 lbs	Free.
56,354	518	1 "	4 p.c., 2 c.c	Free.
90,928	522	3 "	1 p.c	Odd w.b.
146,348	510	3 "	1 p.c., 1 c.c., 1 h.e.m., 2 lbs......	" lambsquarters.
145,378	523	2 "	1 stinkweed	" w.b.

WHEAT CLEANED AND SHIPPED FROM CALGARY.

The information given in the following summary report on the wheat cleaned and shipped from Calgary was compiled in the Calgary seed laboratory. In all cases the analysis takes into account only the weed seeds prohibited by the Seed Control

Act, and is based on the official samples drawn by the grain inspector's staff for commercial grading. Each car was recleaned thoroughly after this analysis was made, so that the grain sent out would be of a considerably higher standard of purity than the report given herewith would indicate. In addition to the following list of cars which were distributed from Calgary, about fourteen car lots were inspected and accepted by the seed inspectors but were not required for seed purposes.

Car Number.	Grade.	Kinds and number, per pound, of Weed Seeds mentioned in Section 6 of Seed Control Act.
46,300	3 Northern	2 wild oats.
94,240	1 "	Free.
36,762	2 "	9 wild oats.
77,314	2 "	2 wild oats, considerable hare's-ear mustard.
17,174	2 "	1 wild oat.
73,116	1 "	1 wild oat.
32 926	2 "	6 wild oats
77,236	2 "	4 wild oats, 1 ball mustard.
37,466	1 "	1 wild oat.
28,696	1 Hard	1 wild oat.
72,318	2 "	Free.
43,458		Free.
44,368	2 "	1 wild oat in 2 lbs.
92,488	3 "	1 wild oat in 2 lbs

WHEAT PURCHASED AT EDMONTON.

The analysis of the wheat purchased at Edmonton as given below is based on the original inspection certificate. As at the other points, the grain was thoroughly cleaned after inspection. The car numbers are for the grain as it was purchased and these may or may not correspond with the car number as the grain was sent out.

Car Number.	Grade.	Kinds and number, per pound, of Weed Seeds mentioned in Section 6 of Seed Control Act.
39,212	2 Northern	Free.
2,174	2 "	2 wild oats, odd wild mustard.
38,046	1 "	Free.

SEED OATS BOUGHT IN WESTERN CANADA, CLEANED AND DISTRIBUTED IN WINNIPEG.

The following car lots of oats bought in western Canada were cleaned and distributed from Winnipeg. In nearly all cases these oats graded No. 2 white. Unless otherwise mentioned, each car was made up of one lot of oats and the one certificate covers the whole car.

Car Number.	Percentage of Seeds Germinable in Soil.	Kinds and number per pound of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
38,200*	100	4 wild oats	Odd wild buckwheat and black oat.
41,100	66	2 " , 2 ball mustard	Free.
35,400	89	40 " , 1 purple cockle	A few black oats.
75,210	82	20 " "	Odd wild buckwheat and black cats.
50,510	89	4 " "	Odd black oats.
144,710	100	6 " "	" "
98,910	72	16 " "	" "
141,420	88	20 " "	" "
58,620	91	4 " "	" "
59,920	91	Free	" " & w.b.
39,030	96	1 wild oat, 1 wild mustard, 1 ball mnstard	Free.
42,630	100	2 wild oats	Odd black oat.
42,240	78	24 wild oats, 1 purple cockle	" "
73,240	97	1 wild oat	Odd wild buckwheat.
78,150	93	8 " "	Odd black oat.
73,060	84	14 " "	" "
99,060	97	2 " "	Odd grain of wheat.
93,260	99	4 " "	Odd black oat.
39,460	94	8 " "	" "
41,170	93	6 " "	" " and wheat.
34,580	86	50 wild oats, 1 purple cockle, 1 ball mustard	Odd grain of wheat.
17,580	96	6 wild oats	" "
20,780	95	Free	Considerable black oats.
15,880	91	1 wild oats	Odd wild buckwheat.
56,090	96	1 " "	Odd black oat.
59,690	78	9 " "	Odd black oat and wild buckwheat.
144,402	87	4 " "	Free.
43,902	61	6 " "	Odd wild buckwheat.
49,112	92	16 " "	Odd black oat and wheat.
141,512	76	1 " "	Odd black oat.
15,912	91	2 cow cockle	Odd wild buckwheat.
44,222	95	2 wild oats	Odd black oat.
40,622	77	1 " "	" "
38,722	85	2 " "	A little wheat.
91,332	95	2 " "	Odd wild buckwheat and black oats.
35,632	93	6 " " , 4 ball mustard	Odd black oat.
53,242	48	15 " "	Free.
17,442	95	6 " "	Odd wild buckwheat.
38,642	95	6 " "	Odd black oat.
39,742	91	6 " " , a little ball mustard	" "
57,942	86	Free	Considerable flax.
30,052	93	6 wild oats	Odd black oat.
94,052	81	10 " "	" " and wild buckwheat.
31,752	80	10 " "	" "
41,062	98	20 " " , a little cow cockle	Free.
2,862	76	6 " "	Odd black oat.
44,272	84	4 " "	" "
76,472	81	1 " "	Odd wild buckwheat.
41,772*	98	12 " "	Odd black oat and wild buckwheat.
48,972	91	40 " "	" "
42,092	92	3 " "	Odd wild buckwheat and barley.
145,392	96	3 " "	Odd black oats and wild buckwheat.
44,592	89	24 " " , 1 cow cockle	" " and wheat.
39,204	99	5 " "	Odd wild buckwheat.
57,214	75	4 " "	Free.
71,414	95	10 " " 2 ball mustard	Odd black oat.
52,914	93	6 " "	" " "
147,914	95	4 " "	" " "

*38,200 This car contains 384 sacks, 1 white, germinating 97%.
*41,772 This car, after being sent out, was recalled and replaced.

SEED Oats Bought in Western Canada—*Continued.*

Car Number.	Percentage of Seeds Germinable in Soil.	Kinds and number per pound of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
87,024	97	10 wild oats, 2 cow cockle	Odd black oat and wild buckw.
40,724	98	2 " "	" " " " " "
21,924	94	10 " " some ball mustard	Free.
91,134*	84	10 " "	Odd black oat and wild buckw.
21,334	99	2 " "	Odd wild buckwheat.
77,334	83	12 " "	Odd black oats.
4,434	97	12 " "	Odd wild buckwheat and Bl. oat.
37,584	87	18 " "	Odd black oat.
35,834	86	4 " "	Odd wild buckwheat and Bl. oat.
54,144	85	10 " "	" " "
23,054	89	12 " "	" " "
17,054	97	4 " "	" " "
140,354*	97	15 " "	Considerable lambsquarters.
11,454	97	10 " " 4 ball mustard	Odd wild buckwheat.
93,454	93	4 " "	" " " and black oat.
36,454	85	8 " "	Odd black oat and wheat.
141,754	91	10 " "	" " "
12,954	100	6 " "	Odd w. buckwheat and black oats.
19,074	82	18 " "	Odd wild buckwheat.
29,574	94	2 " "	Odd black oats.
140,774	94	8 " "	" " " and wheat.
93,384	51	2 " "	Odd wild buckwheat.
45,384	94	15 " " 4 purple cockle	" " "
145,584	92	14 " " 4 ball mustard	Odd black oat.
38,584	92	6 " "	" " "
71,394*	86	6 " "	Odd wild buckwheat.
46,006	94	6 " "	Odd black oat.
53,106	93	4 " " 6 cow cockle, 4 ball mustard.	Free.
146,406	69	4 " "	Odd wild buckwheat.
41,906	77	14 " "	Free.
50,416	72	8 " "	Odd black oat.
71,616	82	2 " "	Odd wild buckwheat.
49,026	81	20 " "	" " " and bl. oat.
34,036	98	25 " " 2 purple cockle	" " "
144,836	80	10 " "	Odd black oat.
42,936	88	16 " "	" " "
147,646	64	2 " "	Free.
71,656	96	8 " "	Odd wild buckwheat and bl. oat.
38,656	72	12 " "	Odd black oat.
51,076	93	4 " "	" " "
24,376	96	9 " "	Odd wild buckwheat and wheat.
22,886	89	16 " "	" " "
98,896	78	53 " "	" " "
52,996	87	Free	Odd black oat.
57,108	91	6 wild oats, 2 ball mustard	" " "
21,208	91	2 " "	" " "
74,308	92	4 " " 2 cow cockle, 2 purple cockle	Considerable wheat.
42,508*	89	Free	Odd wild buckwheat.
34,608	89	12 wild oats, 4 cow cockle, 6 ball mustard.	Odd black oat.
140,218	88	4 " "	" " "
32,128	83	12 " "	" " "
45,228	98	2 " " 2 purple cockle	Odd wild buckwheat.
71,428	95	Free	" " " and bl. oat.
43,638	80	25 " " 2 purple cockle	Odd black oat.
32,248	88	18 " " 2 purple cockle	" " " and wheat.
55,348	95	1 " "	" " "
76,158	84	4 " "	" " "
32,068	95	8 " "	" " "
42,068	73	4 " "	" " "
73,368	87	1 " "	Odd wild buckwheat.
54,368	96	8 " " 2 ball mustard	" " " and bl. oat.
41,668	95	2 " "	" " "
53,778	47	6 " "	Odd black oat.
40,878	83	10 " "	Odd wild buckwheat.

*91,134 Above analysis is for 464 sacks, 2 white oats. Balance of car Prince Edward Island oats.
*140,354 Above analysis for 2 white oats. This car also contains 144 sacks No. 1 white oats.
*71,394 This car, after being sent out, was recalled and replaced.
*42,508 This car, after being sent out, was recalled and replaced.

SEED Oats Bought in Western Canada—*Continued.*

Car Number.	Percentage of seeds Germinable in soil.	Kinds and Number per pound of Weed Seeds mentioned in Section of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
21,488	98	10 wild oats	Odd black oat.
59,888	94	Free	"
56,298	98	2 wild oats	" and flax.
41,398	94	14 wild oats, 5 ball mustard	" and wild buckw.
35,398	96	3 wild oats	"

OATS BOUGHT IN WESTERN CANADA, CLEANED AND DISTRIBUTED FROM BRANDON.

51,920	59	1 wild oat, 1 ball mustard	Odd black oat.
25,230	79	1 ball mustard	"
26,330	89	4 wild oats	Odd wild buckwheat and flax.
145,650	82	Free	Odd black oat and wheat.
21,960	92	6 wild oats	Odd wild buckwheat and wheat.
98,880	90	Free	Some black oats and wheat.
22,722	88	9 wild oats, 8 purple cockle	Considerable wheat.
29,142	94	12 wild oats	Odd wild buckwheat.
17,342	83	1 ball mustard	Odd black oat and wheat.
55,962	86	1 wild oat	"
92,072	75	Free	"
33,304	97	2 wild oats	Odd wild buckwheat and wheat.
33,304	90	22 wild oats	Odd black oats.
71,124	91	3 wild oats, 2 purple cockle	Some wild buckwheat and wheat.
75,534	68	25 wild oats	Odd black oat.
72,444	69	1 wild oat	Odd wild buckwheat.
42,306	97	8 " oats	"
28,716	88	3 " "	Odd black oat and buckwheat.
40,326	89	1 " oat	Some black oats and wheat.
98,596	85	1 " "	Odd wild buckwheat.
53,008	87	1 " "	Odd black oat and wild buckw.
20,408	93	2 " oats	" wheat.
13,328	98	Free	Odd wild buckwheat and wheat.
47,448	53	6 wild oats	Odd black oat and wild buckw.
43,548	84	3 " "	" wheat and barley.
46,548	91	7 " "	Odd wild buckwheat and flax.
147,648	88	4 " "	Odd black oat and wheat.
33,988	73	1 " oat	"
34,568	96	1 " "	" and wheat.

OATS BOUGHT IN WESTERN CANADA, CLEANED AND DISTRIBUTED FROM REGINA.

25,320	83	2 wild oats	Odd black oat.
40,670	84	5 " oats	Odd wild buckwheat and wheat.
54,912	82	1 " oats, 1 ball mustard	" "
18,704	88	4 " oats	Odd black oat and wheat.
72,744	94	1 " oat	Odd wild buckwheat.
45,078	81	4 " oats	Odd black oat and wheat.

OATS BROUGHT IN WESTERN CANADA, CLEANED AND DISTRIBUTED FROM CALGARY.

As in the case of wheat, the analysis of the oats shipped from Calgary, given below, is based on the official samples drawn by the grain inspector's staff before the grain was cleaned. In all, 77 cars of oats were accepted by the seed inspectors in Calgary, but of this number only the following were distributed for seed:—

Car Number.	Percentage of Seeds Germinable in Soil.	Grade.	Kinds and Number, Per Pound, of Weed Seeds mentioned in Section 6 of Seed Control Act.
90,110	95	No. 2	Free.
46,210	72	No. 2	6 wild oats, 4 ball mustard.
44,130	99	No. 2	4 wild oats.
40,630	92	No. 3	4 wild oats, some ball mustard.
52,580	99	No. 2	Free.
53,502	73	No. 2	2 wild oats.
55,782	71	No. 2	14 wild oats, some ball mustard.
58,492	82	No. 3	10 wild oats, some ball mustard.
55,592	82	No. 3	10 wild oats, some ball mustard.
55,592	74	No. 3	4 wild oats, some ball mustard.
78,592	82	No. 2	12 wild oats, 12 ball mustard.
*49,404	74	No. 3	4 wild oats, some ball mustard.
92,214	82	No. 2	10 wild oats, some ball mustard.
41,954	95	No. 1	14 wild oats.
72,684	99	No. 2	Free.
57,094	75	No. 2	20 ball mustard.
*71,016	60	No. 3	8 wild oats, some ball mustard.
73,636	82	No. 3	4 wild oats.
77,296	82	No. 2	Some ball mustard.
57,308	92	No. 3	4 wild oats, some ball mustard.
53,228	96	No. 2	10 ball mustard.
74,738	97	No. 2	Free.
90,158	66	No. 2	2 wild oats.
72,758	83	No. 2	6 wild oats, 4 ball mustard.
48,688	87	No. 2	16 wild oats, some ball mustard.
73,298	100	No. 1	Free.

* These cars after being sent out, were recalled and replaced.

OATS PURCHASED AT EDMONTON.

The analysis of the oats purchased at Edmonton, as given below, is based on the original inspection certificate. As at the other points, the grain was thoroughly cleaned after inspection. The car numbers are for the grain as it was purchased, and these may or may not correspond with the car numbers as the grain was sent out. As was previously stated, these oats were of the 1906 crop, and germination tests were considered unnecessary.

Car Number.	Grade.	Kinds and Number, Per Pound, of Weed Seeds mentioned in Section 6 of Seed Control Act.
72,200	No. 1	20 wild oats, odd wild mustard.
38,242	No. 1	Free.
71,552	No. 1	18 wild oats, odd wild mustard.
58,852	No. 2	8 wild oats, odd wild mustard.
76,404	No. 2	18 wild oats.
78,154	No. 1	20 wild oats, odd ball mustard.
73,214	No. 1	18 wild oats, odd ball mustard.
37,394	No. 2	2 wild oats, odd ball mustard.
25,566	No. 1	22 wild oats, odd ball mustard.
90,386	No. 1	22 wild oats, odd ball mustard.
77,724	No. 3	20 wild oats, odd ball mustard.
91,004	No. 1	14 wild oats.
78,156	No. 1	12 wild oats.
92,546	No. 1	20 wild oats.
72,576	No. 1	14 wild oats.

ONTARIO OATS.

The following cars of oats were purchased in Ontario through the Steele, Briggs Company, and were cleaned and sacked before shipping to the western provinces. In all cases these oats were inspected under Seed Control Act standard, which limits the impurities to one noxious weed seed per pound.

Car Number.	Grade.	Contents of Car.
24,320	No. 1.......	253 sacks Sensation, 58 sacks 20th Century, variety.
90,884	" 1.......	308 sacks (1,100 bus.) Ligowa variety.
33,416	" 1.......	1,200 bus. Sensation variety.
16,018	" 1.......	367 sacks Sensation variety.
41,754	" 1.......	1,200 bus. Dewdrop, 300 bus. Sensation.
14,582	" 1.......	250 sacks Sensation, 100 sacks Ligowa, 33 sacks 20th Century.
29,735	" 1.......	1,200 bus. 20th Century.
15,496	" 1.......	570 bus. Banner, 243 bus. Sensation, 759 bus. Prospect, 144 bus. 20th Century.
21,332	" 1.......	208 sacks Scottish Chief, 129 Ligowa, 95 Banner, 68 Tartar King.
15,681	" 1.......	220 sacks Scottish Chief, 110 sacks Banner, 70 sacks Ligowa, 100 Tartar King.
76,120	" 1.......	145 sacks Banner, 100 sacks Sensation.
78,132	" 1......	1,500 bus. white oats (variety not named).

ONTARIO OATS CLEANED AND DISTRIBUTED FROM WINNIPEG.

Car Number.	Percentage of seeds Geminable in soil.	Grade.	Kinds and Number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
38,200*	97	No. 1....	Free..........................	Some buckwheat and wheat.
36,626	91	" 2.....	4 wild oats.....................	Free.
48,476	94	" 1.....	1 wild oat......................	Odd grain of wheat.
98,404	94	" 1.....	4 wild oats.....................	Odd wild buckwheat.
73,984	97	" 2.....	3 wild oats.....................	Odd wild buckwheat.
94,686	96	" 1.....	Free............................	Odd grain of wheat.
54,878	97	" 1.....	3 wild oats.	Odd vetch.

* Part of this car was loaded with No. 2 western oats.

PRINCE EDWARD ISLAND OATS.

The following cars of Prince Edward Island oats were cleaned and sacked at the Winnipeg cleaning elevators :—

Car Number.	Percentage of seeds Germinable in soil.	Kinds and Number per lb. of Weed Seeds mentioned in Section 6 of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
91,800	95	Free	Odd black oat and vetch.
21,320	94	"	" vetch and buckwheat.
76,520	87	"	" " "
93,620	86	"	" " "
77,140	90	1 wild oat in 1¼ lbs	" " barley.
41,170*	96	Free	" "
92,370	89	1 wild oat in 1¼ lb	" " and buckwheat.
90,880	94	Free	" " " "
71,090	89	"	" " " "
54,090	91	"	" " " "
57,502	92	"	" " " "
74,612	85	"	" " " "
41,322	87	"	" " " "
59,622	88	"	" " " "
53,432	88	"	" " " "
77,242	92	"	" " " "
76,642	88	1 wild oat in 1¼ lb	" " " "
49,252	92	Free	" " " "
75,262	79	"	" " " "
142,372	91	"	" " " "
92,572	88	"	" " " "
59,882	83	1 wild oat in 1¼ lb	" " " "
54,592	95	Free	" " " "
90,004	78	"	" " " "
146,304	96	"	" " " "
72,404	87	"	" " " " and a little wheat.
50,904	89	1 wild oat in 1¼ lb	Odd black oat, buckwheat and barley.
38,914	90	Free	" and vetch.
91,134*	82	"	" vetch and buckwheat.
79,234	87	"	" " buckw. and barley.
98,864	91	2 wild oats in 1¼ lbs	" " and buckwheat.
45,074	100	Free	" " barley and buckw.
38,284	89	1 wild oat in 1¼ lb	" " " "
55,384	82	Free	Odd vetch and buckwheat.
39,594	88	"	Odd vetch black oat, barley and wheat
91,306	87	"	" " " buckw.
77,806	84	"	" " " "
56,626	80	"	" " " "
44,236	90	"	" " " "
38,436	93	1 wild oat in 1¼ lb	" " " "
140,836	81	Free	" " " "
72,156	85	"	" " " "
74,266	81	"	" " " "
51,466	86	"	" " " "
46,676	80	"	" " wheat "
40,918	90	1 wild oat in 1½ lb	Odd black oat and buckwheat.
45,328	80	Free	" vetch, buckw. and barl.
49,528	92	1 wild oat in 1¼ lb	" " " "
98,528	81	1 wild oat	" and vetch.
46,848	90	Free	" vetch, buckw. and barl.
40,558	92	1 wild oat in 1½ lb	" " " "
93,268	93	Free	" " " "
91,668	84	"	" and vetch.
53,768	86	"	" vetch and buckwheat.
76,378	91	"	" vetch, buck. and barley.
44,578	92	"	" vetch, buck. and wheat.
71,678	83	1 wild oat in 1¼ lb	" " " "
90,778	94	Free	" vetch and buckwheat.
55,878	96	"	" " " "
145,688	84	"	" vetch, buckw. and wheat
75,798	89	2 wild oats in 1¼ lbs	Black oat, vetch, buckwheat and barley

*41,170, Part of this car was loaded with No. 3 oats.
*91,134, Part of this car was loaded with No. 2 oats.

BRITISH OATS.

The following is a summary analysis of the British seed oats cleaned and sacked at the Winnipeg elevators:—

Car Number.	Percentage of seeds Germinable in soil.	Kinds and Number per lb. of Weed Seed mentioned in Section 6 of Seed Control Act.	Impurity not mentioned in Section 6 of Seed Control Act.
16,400	87	1 wild oat.	Odd cleavers.
38,610	97	Free	" and wild buckwheat.
19,620	82	"	Free cleavers "
1,820	88	"	"
41,030	94	1 wild oat in 1¼ lb	Odd cleavers and wild buckwheat.
91.230	86	Free	" and poppyhead
42,840	94	1 wild oat in 1¼ lb	" and wild buckwheat.
40,050	90	2 wild oats in 1½ lbs.	"
1,150	89	1 wild oat in 1½ lb.	"
32.350	95	Free	" and wild buckwheat.
76,350	89	1 wild oat in 1¼ lb	"
56,060	82	1 wild mustard	" and wild buckwheat.
32,560	82	1 wild oat	" "
92,570	80	Free	Odd barley grain.
41,770	94	"	Odd cleavers and wild buckwheat.
39,380	99	"	" "
21,480	92	1 wild oat in 1¼ lb.	" "
36,680	89	1 " "	" "
43,780	93	Free	" " and barley.
44,190	92	2 wild oats	" "
98,790	84	1 wild oat	"
39,890	95	Free	" and wild buckwheat.
44,102	92	1 wild oat	" "
46,102	87	Free	" "
40,402	96	2 wild mustard	" "
40,012	84	Free	" " and poppyhead.
40,712	93	1 wild oat in 1¼ lb	" "
76,912	85	Free	Odd grain of wheat.
39,322	89	"	Odd buckwheat and black oat.
37,632	82	2 wild oats in 1½ lb	Odd cleavers and wild buckwheat.
32,042	84	2 wild oats	Odd wild buckwheat.
112,142	84	Free	Odd cleavers.
43,052	90	1 wild oat in 1¼ lb.	"
37,152	82	2 wild oats in 1½ lb	"
53,552	90	1 wild oat in 1½ lb	"
1,652	87	Free	" and barley grain.
38,752	91	"	" buckwheat and barley.
40,162	83	2 wild oats, odd wild mustard	Odd barley grain.
45,362	88	1 wild mustard	Odd cleavers.
78,862	84	1 wild oat in 1½ lb.	Odd barley grain.
13,072	82	1 wild oat, 1 wild mustard	Odd cleavers and wheat.
1,172	85	2 wild oats, odd wild mustard	" and wild buckwheat.
76,172	91	Free	"
54,372	84	1 wild oat in 1¼ lb.	"
37,472	84	2 wild oats in 1¼ lb. and odd wild mustard	" and wild buckwheat.
35,572	93	1 wild oat, 2 wild mustard in 1½ lb.	" and barley.
78,572	91	2 wild oats	"
35,872	97	Free	" and barley.
95,082	84	"	" and wild buckwheat.
42,382	86	1 wild oat	"
4,482	91	Free	"
42,682	91	1 wild oat	" and wild buckwheat.
38,882	90	Odd wild mustard	" "
4,192	85	1 wild oat in 1¼ lb.	"
54,292	83	1 pod wild mustard	"
28,392	97	1 wild mustard	" and wild buckwheat.
2,492	94	Free	Odd wild buckwheat and black oats.
43,492	85	2 wild oats	Odd cleavers and wild buckwheat.
34,404	87	Odd wild mustard	Odd cleavers and barley grain
92,604	81	1 wild oat in 1¼ lb.	Odd cleavers and wild buckwheat
34,604	88	1 wild oat	Odd wild buckwheat
57,704	93	1 wild oat in 1½ lb.	Odd cleavers
2,804	91	Free	Odd cleavers and barley

BRITISH OATS—*Continued.*

Car. Number.	Percentage of Seeds Germinable in soil.	Kinds and Number per lb. of Weed Seed mentioned in Section 6 of Seed Control Act.	Impurity not mentioned in Section 6 of Seed Control Act.
41,414	86	1 wild oat in 1¼ lb	Odd cleavers and wild buckwheat
94,024	80	Free	" "
4,424	96	"	Free
42,624	91	2 wild oats	Odd cleavers and wheat
140,924	88	1 wild oat in 1¼ lb	Odd cleavers, wild buckwheat and poppyhead
24,234	82	Free	Odd cleavers and wild buckwheat
3,534	85	1 wild oat in 1½ lb	Odd cleavers
41,634	96	Free	Odd cleavers and wild buckwheat
91,844	95	"	Odd cleavers and buckwheat
29,154	94	"	Odd cleavers
11,864	87	"	Odd cleavers and wild buckwheat
75,864	97	"	" "
45,174	89	"	" "
3,574	83	1 purple cockle in 1¼ lb	Odd wild buckwheat
39,184	88	1 wild oat	Odd cleavers, buckwheat and barley
53,484	88	1 wild oat in 1½ lb	Free
57,194	86	Free	Odd cleavers
32,294	84	"	Odd cleavers and wild buckwheat
40,694	91	1 wild mustard	" "
42,206	88	1 wild oat in 1½ lb	" "
506	82	Free	Odd cleavers, buckwheat and barley
141,506	88	2 wild oats	Odd cleavers
35,506	83	1 wild oat, odd w. mustard	Odd cleavers and buckwheat
22,606	95	1 wild oat in 1¼ lb	" "
34,606	90	Free	" "
38,216	93	"	Odd cleavers
145,616	89	3 wild oats	Odd cleavers and buckwheat
36,226	96	Free	Odd cleavers and wheat
26,326	88	1 wild oat in 1¼ lb.	1 poppyhead in 1½lb
38,336	90	" "	Odd cleavers
72,536	82	3 wild oats, odd wild mustard	Odd barley grain
91,246	78	2 wild oats	Odd cleavers
4,346	87	Free	Odd cleavers and buckwheat
40,556	90	2 wild oats, odd w. must	Odd cleavers and wild buekwheat
36,076	87	1 wild oat in 1¼ lb	Odd wheat and poppyhead
99,176	93	Free	Free
42,676	90	"	Odd cleavers and wild buckwheat
42,776	85	3 wild oats, odd wild mustard	" "
93,186	90	1 wild oat in 1½ lb	Odd grain barley
44,096	91	2 wild oats	"
42,996	92	1 wild oat in 1¼ lb	Odd cleavers, wild buckwheat and barley
42.308	97	1 wild oat in 1½ lb	
43,308	....	1 " "	Odd poppyhead
43,708	90	1 " "	Odd cleavers and wild buckwheat
30,018	91	Free	Odd cleavers
20,418	86	2 wild oats	Odd cleavers and vetch
41,418	94	Free	Odd cleavers
91,518	87	2 wild oats	Odd cleavers and wild buckwheat
20,618	87	Free	Odd black oat
38,718	94	"	Odd cleavers and wild buckwheat
33,028	85	2 wild oats	Odd grain barley
41,228	85	Free	Odd cleavers
36,328	85	"	Odd cleavers and wild buckwheat
14,738	89	"	Odd cleavers
38,838	93	1 wild oat	"
4,448	88	2 w. o. in 1¼ lb	"
12,158	87	Free	Odd cleavers and wild buckwheat
41,558	90	"	" "
18,558	91	"	" "
42,958	86	2 wild oats	Odd cleavers
59,068*	84	Free	Odd cleavers and wild buckwheat
144,368	93	"	" "
40,468	85	1 wild oat	Odd cleavers.
3,978	93	1 "	Odd cleavers and wild buckwheat.
44,378	93	3 w.o., odd wild mustard	" "
44,978	85	1 wild oat, 1 purple cockle in 1½ lbs	Free.

*59,068 Part of this car loaded with 3 Northern wheat.

BRITISH OATS—*Continued.*

Car Number.	Percentage of seeds Germinable in soil.	Kinds and Number per lb. of Weed Seed mentioned in Section 6 of Seed Control Act.	Impurity not mentioned in Section 6 of Seed Control Act.
54,288	89	1 wild oat in 1¼ lbs.	Odd cleavers.
3,488	94	Free	"
39,688	91	1 wild oat in 1⅓ lb., odd wild mustard	Odd cleavers and wild buckwheat.
37,693	87	1 wild oat in 1¾ lb.	Odd cleavers.
36,798	83	1 " "	Odd cleavers and vetch.

BRITISH OATS CLEANED AT FORT WILLIAM.

56,700	94	2 wild oats	Odd cleavers, w. b., barley and wheat.
147,950	97	2 wild oats, 1 wild mustard	" " " and shepherd's needle.
72,980	95	1 wild oat	Odd cleavers, wild buckwheat, wild radish, barley and wheat.
91,802	93	2 wild mustard, 3 wild oats	Odd cleavers, wild buckwheat, wild radish and barley.
94,712	93	3 wild oats	Odd cleavers, wild buckwheat, wild radish, wheat and barley.
92,222	85	2 "	Odd cleavers, wild buckwheat, barley and wheat.
53,632	91	3 "	Odd cleavers, buckwheat, wild radish and barley.
77,252	95	2 wild oats, 1 wild mustard	Odd cleavers, wild buckwheat, wild radish and barley.
36,752	94	2 wild mustard	Odd cleavers, wild buckwheat, wild radish, barley and shepherd's needle.
75,662	95	3 wild oats	Odd cleavers, wild buckwheat, shepherd's needle and hemp nettle.
34,762	91	3 "	Odd cleavers, wild buckwheat, barley shepherd's needle and hemp nettle.
46,672	99	1 wild oat	Odd cleavers, wild buckwheat, barley and shepherd's needle.
94,582	84	1 wild oat, 1 wild mustard	Odd cleavers, wild buckwheat, barley and shepherd's needle.
147,492	88	3 wild oats	Odd cleavers, wild buckwheat and barley.
94,724	95	1 wild mustard	Odd cleavers, wild buckwheat, wild radish, barley and wheat.
93,654	91	3 wild oats, 2 wild mustard	Odd cleavers, wild buckwheat, wild radish and barley.
14,064	90	1 wild oat, 1 wild mustard	Odd cleavers, wild buckwheat, barley and shepherd's needle.
142,464	99	Free	Odd cleavers, wild buckwheat, wild radish, barley and wheat,
56,374	92	1 wild oat	Odd cleavers, wild buckwheat and barley.
56,384	94	4 wild oats, 1 wild mustard	Odd cleavers, wild buckwheat, wild radish, shepherd's needle and barley.
92,794	93	1 wild oat	Odd cleavers, wild buckwheat, barley and wheat.
32,206	96	3 wild oats	Odd cleavers, wild buckwheat, wild radish, barley and shepherd's needle.
54,546	93	1 wild oat, 1 wild mustard	Odd cleavers, wild buckwheat and barley.
76,946	87	5 wild oats	" " "
90,696	89	2 wild oats, 2 wild mustard	Odd cleavers, wild buckwheat, barley and shepherd's needle.
76,018	85	3 wild oats	Odd cleavers, wild buckwheat, barley and vetch.
52,718	93	1 wild oat, 3 wild mustard	Odd cleavers, wild buckwheat, barley and shepherd's needle.
43,538	91	3 wild oats	Odd cleavers, wild buckwheat, wild radish, barley and wheat.
36,948	97	3 wild oats, 1 wild mustard	Odd cleavers, wild buckwheat, wild radish and barley.
29,768	86	5 wild oats, 11 wild mustard	Odd cleavers, wild buckwheat, wild radish and barley.
91,998	97	4 wild oats, 2 wild mustard	Odd cleavers, wild buckwheat, barley and wheat.

Owing to the fact that requisitions were not received for the *Empress of Britain* shipment, which was cleaned at Fort William, until the grain was cleaned and sacked, it was impossible to get representative samples of the individual cars as billed out. An analysis was made of each car after being cleaned and the shipment proved to be very uniform throughout. From the analysis of the various cars comprising the shipment, the following general report has been made out, which may be taken as fairly accurate for any car in the list given below. Kinds and number per pound of weed seeds mentioned in section 6 of the Seed Control Act; one wild oat, one wild mustard. Kinds of weeds and other impurities not mentioned in section 6 of the Seed Control Act, odd cleavers, wild buckwheat, barley, wheat, shepherd's needle, lady's thumb, wild radish, corn ranunculus, Good King Henry, and wild vetch.

The highest number of weed seeds mentioned in section 6 found in any car of the shipment was four (wild oats), while some cars were entirely free.

The average percentage germination of the entire shipment was 88, the highest being 100 and the lowest 76. The following is a list of cars loaded from the shipment covered by the above analysis:—41,000, 41,720, 91,140, 39,740, 40,850, 43,980, 39,490 44,502, 75,312, 43,022, 90.922, 44,432, 43,052, 91,052, 147,752, 43,862, 43,972, 38,092, 145,624, 43,724, 40,094, 42,294, 39,594, 41,516, 38,466, 43,386, 98,548, 42,078, 43,578, 42,298, 42,598, 37,998.

BARLEY.

The following is a summary analysis of the barley cleaned and shipped from Winnipeg cleaning elevators:—

Car Number.	Number of sacks in car.	Grade.	Kinds and Number per lb. of Weed Seeds mentioned in Sec. 6 of Seed Control Act.	Impurities not mentioned in Section 6 of Seed Control Act.
145,800	505	3x	1 wild oat	Odd grain wheat.
145,800	234	2x	2 wild oats......	Odd tame oat and vetch.
59,800	450	2	1 wild oat, 1 purple cockle.......	" "
37,430	340	3x	2 wild oats	Odd grain wheat.
37,430	285	2x	Free	Odd vetch.
147,520	189	3x	2 wild oats........	"
147,520	604	2x	2 "	" and tame oat.
59,360	630	2	2 " 1 purple cockle.......	Odd grain wheat.
91,780	115	2x	2 "	Odd vetch and tame oat.
91,780	552	3x	2 "	Odd vetch and w. buckwheat.
76,590	325	1x	1 wild oat.........	" "
76,690	300	2	1 wild oat, 4 purple cockle in 2 lbs.	"
54,612	468	2x	1 c.c., 1 p.c. in 2 lbs............	Odd grain wheat.
54,612	157	1x	1 wild oat.....	Odd wild buckwheat.
74,222	644	3x	2 wild oats..........	Odd vetch and w. buckwheat.
77,622	600	2x	2 "	Odd wild buckwheat.
42,442	485	2x	3 "	Odd vetch and w. buckwheat.
94,842	625	2	3 "	"
94,252	409	3x	2 "	" and w. buckwheat.
51,782	625	2	6 "	"
42,192	635	2x	1 wild oat in 2 lbs.	"
90,492	465	2x	1 wild oat in 1½ lbs......... .	"
77,592	372	2x	1 wild oat in 1½ lbs....	"
77,592	68	3x	1 wild oat........................	Odd w. buckwheat and wheat.
48,304	331	2x	2 wild oats....	Odd vetch and tame oat.
48,304	384	3x	3 "	" "
44,704	620	2	7 "	"
75,034	544	2x	1 wild oat in 2 lbs...	" and tame oat.
44,434	625	2	5 wild oats..........	"
58,384	445	3x	1 wild oat	Odd grain wheat and w. buckw.
32,684	522	3x	1 wild oat	Odd vetch and wheat.
38,694	625	2	8 wild oats..	"
99,016	427	2	1 purple cockle	Odd grain wheat and tame oat.
37,536	625	2	5 wild oats	Odd vetch.
94,676	526	2x	1 wild oat in 2 lbs........... ...	"
94,676	134	3x	2 wild oats.....................	"
78,888*	525	3x	6 "	" and wheat.
37,098	550	3x	3 "	" "

* 78,888. This car also contains 120 sacks 2x barley.

BARLEY PURCHASED AT EDMONTON.

Two cars of barley were purchased at Edmonton, car No. 47822, graded No. 2, and contained 20 wild oats per pound before cleaning. Car No. 2174, graded No. 2, contained six wild oats per pound before cleaning. The car numbers given are as the grain was purchased, and these numbers may or may not correspond with the car numbers as it was billed out.

SUMMARY REPORT

OF THE

DEPARTMENT OF MINES

GEOLOGICAL SURVEY

FOR THE CALENDAR YEAR

1907

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1908

To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G.C.M.G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY,—

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII., chapter 29, section 18, the Summary Report of the operations of the Geological Survey during the year November 30, 1906, to November 30, 1907.

WILLIAM TEMPLEMAN,

Minister of Mines.

Hon. Wm. Templeman,

Minister of Mines,

Ottawa.

Sir,—I have the honour to submit herewith the Acting Director's Summary Report of the operations of the Geological Survey during the year November 30, 1906, to November 30, 1907.

I am, sir,

Your obedient servant,

J. F. WHITEAVES,

Acting Deputy Minister.

TABLE OF CONTENTS.

SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY OF CANADA

FOR THE CALENDAR YEAR 1907

J. F. WHITEAVES, Esq.,
Acting Deputy Minister,
Department of Mines.

SIR,—As Acting Director I have the honour to submit, herewith, the Summary Report of the Geological Survey of Canada for the Calendar year 1907.

The prompt publication of last year's Summary Report—which was issued within ten days of the close of the year—elicited favourable comment from the daily and scientific press of the Dominion. Such speedy issue is only possible if the maps and plans, which, for some years, have accompanied the Survey's Summary Reports, be discarded. But, the manner in which last year's report was received by the press and public, leaves no doubt that prompt publication, without maps and plans, is preferred to the later issue, with those accessories included. On this account, it has been decided to again publish the report at the earliest possible moment, that is, directly the field officers are able to furnish an account of their season's work.

The scheme, inaugurated by Dr. Low last season, of distributing free of charge to *bona fide* applicants in Canada, any report that might prove of economic or scientific interest, has met with marked success. Applications for the Survey's reports have been much more numerous, with the result that the work done by this Department is becoming better known and more widely recognized. For two of the most detailed reports issued by the Survey of recent years, namely the report on the region west of Lake Timiskaming, and the Bulletin on Nickel, there was so large a demand that the editions entirely ran out, and it became necessary to order reprints. Owing to the decision to bring the accompanying maps up to date, both geologically and topographically, the issue of these reprints has been unduly delayed, but the Bulletin on Nickel was published a few days ago and the Timagami District report should appear in January.

The problem of quickly supplying the interested portion of the public with the information collected by the Survey is one of considerable difficulty, but the efforts, outlined in last year's Summary, to secure both greater promptness in the publication of such information and the efficient distribution of the same, have been marked by encouraging success and warrant further endeavour along similar lines.

VICTORIA MEMORIAL MUSEUM.

In view of the early completion of this museum, efforts are being made by this Department to procure specimens of some of the larger and rarer mammalia, &c., of the Dominion. Mr. Joseph Keele, who is wintering on the Upper Pelly river, has been particularly instructed to obtain representative specimens of the northern mammalia, and advices received from him before the winter set in report that good fortune had attended his efforts. Arrangements are also being made to secure specimens from other districts.

THE MINERAL INDUSTRY.

Particulars of the mineral production of Canada, which have heretofore been published in this report, will be found in the report of the Mines Branch to which the mining statistical staff has been transferred.

The activity in the mineral districts of Canada during the past year, noticeably in the region about Cobalt and northward to and along the line of the Grand Trunk Pacific railway, has resulted in a pressing demand for geological information concerning these districts. The northern part of the provinces of Ontario and Quebec and the central portion of British Columbia are now calling for a large amount of geological investigation. New Brunswick and Nova Scotia are also demanding that more attention be given to the development of their natural resources. This rapid opening up of the country, and growth of the mineral industry, must be met by a corresponding increase in the activity of the Geological Survey. To meet this growing demand for geological information, an increase in the appropriation for the Survey and an addition to the strength of its technical staff are urgently needed.

FIELD ASSISTANTS.

The system, inaugurated last year, of employing as field assistants, chosen students from the scientific schools of Canada worked very satisfactorily and promises well, both for the Geological Survey, which gains promising recruits for future employment, and for the men themselves, who are enabled to obtain practical experience in the field while pursuing their college courses.

MINERAL COLLECTIONS FOR EDUCATIONAL INSTITUTIONS.

The improved educational collections of minerals enclosed in suitable cabinets, the distribution of which to the High schools of the country was begun last year, have been highly appreciated by the communities into which they have gone and their educational value will be very great. The arrangement and distribution of similar collections will be continued in the coming year. Particulars of this distribution will be found on a later page.

THE LABORATORY.

In the chemical laboratory the operations were conducted by Dr. G. C. Hoffmann, up to the time of his retirement on April 1, assisted by Mr. F. G. Wait; and since that date by Mr. F. G. Wait, assisted by Mr. M. F. Connor.

The specimens submitted to examination have been of the same varied character as in former years, and, in reporting upon them, an endeavour has been made to make the results as practical as possible.

GENERAL INDEX.

The General Index of the Survey's publications, which is a continuation of the Index brought by Mr. Dowling up to 1884, went to press in May and is now very near completion, 960 pages out of a probable 1,050 having been struck off. The compiler has included in the work a great deal more than the contract rendered compulsory, with the result that the usefulness of the book has been very largely enhanced. The scheme of this Index, with its sub-divisions handled in such a manner as to assure references being easily found, is excellent, and the typography, so essential a feature in a book of this kind, is one of the best pieces of work ever turned out by the Printing Bureau.

WORK ON TERTIARY PLANTS OF BRITISH COLUMBIA AND WESTERN CANADA.

During the past year Dr. Penhallow received from Mr. L. M. Lambe, of the Geological Survey, a very extensive collection of Tertiary plants from various localities in British Columbia. The study of this important material necessitated a complete review of all the work previously done with respect to the Tertiary flora of Western Canada, embracing that already reported upon by Sir William Dawson with respect to the Lignite Tertiary of Saskatchewan and Mackenzie river, as well as the work of Heer, and the study of plants derived from British Columbia. The floras thus surveyed have been co-ordinated with the work of Lesquereux, Newberry and others, upon the Tertiary floras of the United States. There has also been brought under consideration a detailed discussion of the cause of the combustion of beds of lignite. In both of these respects conclusions have been reached which seem to offer satisfactory explanations and which establish the probable positions of the various Tertiary beds in Canada.

It has been found that, so far as explored, all of the Tertiary rocks belong to horizons which extend from the Lower Eocene to the Oligocene, or possibly to the Lower Miocene.

INTERNATIONAL COMMITTEE ON CORRELATION OF THE PRE-CAMBRIAN ROCKS.

Reference was made in last year's Summary Report to the progress of the work of the International Nomenclature Committee, consisting of Mr. F. D. Adams, A. E. Barlow, A. P. Coleman, H. P. Cushing, J. F. Kemp and C. R. Van Hise, and it was stated that a report by the committee would be shortly issued.

The report, under the title 'Report of a special committee on the correlation of the Pre-Cambrian rocks of the Adirondack mountains, the original Laurentian area of Canada and Eastern Ontario,' was published in the Journal of Geology, Vol. XV., No. 3, April-May, 1907.

After a resumé of the geology of each area the following conclusions are published as the recommendations of the committee covering correlation and nomenclature.

RECOMMENDATIONS OF THE COMMITTEE CONCERNING CORRELATION AND NOMENCLATURE.

"The committee considers that over the whole area covered by their investigations—namely, the Adirondack mountains, that portion of Eastern Ontario which they examined, the 'Original Laurentian areas' in the province of Quebec and its continuation to the east as far as the River St. Maurice—the Pre-Cambrian sedimentary development is represented by one great series. This series is essentially identical in petrographical character throughout the whole region.

The only locality where the possible (Coleman would say probable) existence of a second unconformable sedimentary series was sugggested by the facts observed, was that on the Queensboro road, east of Madoc, Ontario. It is, however, still a matter of uncertainty as to whether the conglomerate here developed marks the base of an overlying, infolded, unconformable series or not.

In Logan's original classification of the Laurentian this term—apart from the Upper Laurentian which was proved to be composed essentially of anorthosite intrusions—included two series differing in character, namely, the Lower Orthoclase (Fundamental Gneiss) and the Grenville series. Now that investigations have shown that these two series differ in origin, one being essentially a great development of very ancient sediments, and the other consisting of great bodies of igneous rock intruded through them, it becomes necessary to separate these two developments in drawing up a scheme of classification.

As the great intrusions of gneissic granite, forming what has been termed the 'Fundamental Gneiss,' have an enormously greater areal development than the overlying sedimentary series, constituting, as they do, a very large part of the whole northern protaxis, the committee recommend that the term 'Laurentian' be restricted to this great development of igneous gneisses. The nomenclature suggested for the Pre-Cambrian rocks of this eastern region will thus conform, so far as the use of this term is involved, with that suggested by the Special Committee for the Lake Superior region.'

For the overlying sedimentary series the committee recommend the adoption of the name 'Grenville series,' as it is the name originally given by Logan to the series as typically developed about the township of Grenville in the 'Original Laurentian area' on the north shore of the Ottawa river, in the province of Quebec, between the cities of Montreal and Ottawa. The term 'Hastings series' in the opinion of the Committee should be abandoned as a serial name, seeing that the development to which this name was applied by Logan is merely the Grenville series in a less altered form, as Logan in giving the name had conjectured was probably the case. The committee, however, think that it may in some cases be advantageously employed as a qualifying term to designate the less highly altered phase of the Grenville series, which may thus be referred to as the 'Hastings phase' of the Grenville series.

In Canada this Grenville series everywhere on going north is invaded by and frays away into the great Laurentian batholiths, while in the Adirondacks it is cut to pieces by the great intrusions of that area which, when worked out in detail, may prove also to have a more or less similar batholithic form.

The following succession in this region is therefore recognized and adopted by the committee :—

Cambrian—Potsdam sandstones, &c.
(Unconformity).
Pre-Cambrian, Grenville series.
(Intrusive contact).
Laurentian.

The committee consider that it is inadvisable in the present state of their knowledge to attempt any correlation of the Grenville series with the Huronian or Keewatin, so extensively developed in the region of the Great lakes. The Grenville series has not as yet been found in contact with either of these, and until this has been done and the relations of the several series have been carefully studied, their relative stratigraphical position must remain a mere matter of conjecture."

WORK OF THE FIELD OFFICERS.

There were in the field, last season, 20 parties. In addition to the regular officers of the Survey, 3 gentlemen were engaged for the summer on special work, namely:—Messrs. Hunter, Bancroft and Dresser.

The following is a short synopsis of the work performed in the field. It is followed, as usual, by the Summary reports of the field-officers themselves.

With the exception of a short period spent in the Rocky mountains, Mr. R. G. McCONNELL was engaged in investigating the geology and economic features of the copper-bearing rocks in the vicinity of Whitehorse, Yukon. In this work he was assisted by Mr. Maclaren, topographer, who obtained data for and is now compiling a contour map of the district. Mr. Haughton acted as geological assistant. A report on the district, illustrated by maps and sections, is now being prepared and will be sent to press shortly.

Mr. D. D. CAIRNES continued his explorations in the southern portion of the Yukon, chiefly between Whitehorse and Tantalus, where coal and copper were being largely developed. The serious fall in the price of copper will temporarily, at least, retard mining in this district.

Mr. JOSEPH KEELE was commissioned to make an exploratory investigation of a hitherto little known region situated for the most part between lats. 62° and 63°, but which also includes that portion of the Yukon drained by the Upper Pelly and its tributaries, the Hoole, Ross and Kitza rivers.

Mr. Keele, who is wintering on the Upper Pelly, writes that he can find no trace of the existence of an active volcano that prospectors, returning from this district, have reported among the mountains near the source of the Pelly.

Mr. J. AUSTEN BANCROFT was engaged to explore that portion of the coast of British Columbia extending from Powell river to Kingcome inlet, including the adjacent islands. This survey is a continuation of that carried on by Mr. O. E. LeRoy during the summer of 1906. At the time of Mr. Bancroft's visit a considerable amount of copper prospecting was in progress.

Mr. W. W. LEACH continued his investigations in the Bulkley valley. He reports that of the comparatively few new mineral locations taken up, the majority are situated on the headwaters of the Zymoetz river or in the Babine mountains.

Work on the coal properties of the Telkwa river has practically been stopped until the route of the Grand Trunk Pacific has been definitely decided on. Several new areas of coal land have been discovered, one in particular on Goldstream giving promise of becoming of importance.

Owing to the wrecking of all the steamers on the Skeena provisions were scarce and expensive, adding much to the difficulties of prospecting.

Mr. CHARLES CAMSELL was engaged entirely in work of an economic nature in the gold mining camp of Hedley, B.C. The Nickel Plate mine at Hedley is the most important mine in this part of southern British Columbia, and is at present the largest producer of gold alone in the whole province. Besides preparing a topographical map of the camp, the geological work was devoted primarily to a study of the ore deposits and the examination of mineral claims. It is hoped to complete this work early next season.

The WRITER and Mr. W. H. BOYD were employed in extending the mapping of the Lardeau district and in completing the 1,200 foot sheet of the Rossland camp. Mr. Boyd also paid a visit to the Similkameen district to start a topographical survey of that region.

Mr. D. B. DOWLING was mainly engaged in obtaining more details of the coal areas north of the Saskatchewan river, where he had discovered several seams of coal the previous season. He also made an examination of the Athabaska valley.

Mr. G. S. MALLOCH was engaged in completing the photo-topographic survey of the Cascade, Palliser, and Costigan coal basins, in which work he had been engaged while acting as Mr. D. B. Dowling's assistant in the previous year. The survey was carried northwest from Panther creek to the Clearwater river.

Mr. WILLIAM McINNES was instructed to make an exploration of the tract of country in the province of Saskatchewan lying south of the Saskatchewan river and north of the Prince Albert branch of the Canadian Southern railway. This was virtually an extension of the work done last year along the proposed Hudson Bay Railway route. Mr. McInnes reports large areas of very excellent agricultural land that is now not too far from a railway to be available for settlement. The interesting beds of bituminous shales referred to, though not, probably, where seen, of present economic value, may lead to discoveries of greater commmercial interest.

Prof. JOHN MACOUN spent six weeks in western Ontario collecting wood specimens and photographs of trees, and five weeks along the Gaspé coast collecting seaweeds.

Mr. W. H. COLLINS was engaged in a continuation of exploratory work along the National Transcontinental railway westward from Savanne lake for 130 miles. That area consists of Laurentian and Keewatin formations, the former containing feldspar and muscovite, the latter iron, pyrite, and free gold. The agricultural possibilities are fair in the southern portion and the timber is much more valuable than that of the country to the east.

Dr. ROBERT BELL was engaged in the region north of Sault Ste. Marie, and in the area comprised in the Mississagi sheet, in order to complete the topographical work and delineate the geological formations. This work was particularly necessary in order to finish the first surveys, which he made in that district some years ago.

Mr. A. F. HUNTER was employed in the district between Georgian bay and the Ottawa river, in tracing the high-level shorelines at 1,040 feet and 1,430 feet around the high ground in the vicinity of Algonquin park.

Mr. W. A. JOHNSON continued the mapping of the Simcoe and Peterborough area, on which only a small amount of work had hitherto been done by the Survey.

Apart from his work in connexion with the coal tests, mentioned in another part of this report, Mr. THEO. DENIS spent some time in the examination of mineral deposits and occurrences in the region covered by the eastern part of the Bancroft sheet of Drs. Adams and Barlow. This was done in order to fill some gaps in the report on the region, which is now ready for the printer, and to bring up to date the information concerning the working mines and the mineral discoveries in the district.

Mr. Denis was particularly impressed with the possibilities of the marble deposits, from which a great many varieties of ornamental stones could easily be obtained along the northern part of the Central Ontario railway, between L'Amable station and Bancroft.

At the present time the building of large edifices is extensively going on in eastern Canada, and the attention of architects may, to great advantage, be called to the apparently unlimited supplies of various marbles which could be extracted for decorative purposes.

Mention may also be made of the large deposit of sodalite which is now being developed near the town of Bancroft. The company owning it will soon be in a position to put on the market a beautiful ornamental stone, of various shades of blue, which takes a very high polish and is eminently well suited for decorative purposes.

At the time of Mr. Denis' visit to the district, metalliferous mining was represented by the active operations of the Mineral Range Iron Company, at Bessemer, Hastings county, which is working an apparently important deposit of magnetite; and the Hollandia mine near Bannockburn, which was operating on a deposit of galena. Other mineral enterprises are in a latent state, and many deposits are being prospected and developed.

In August Mr. Denis made a short trip to St. Joseph de Pierreville to investigate a find of natural gas reported to the Department by Mr. J. Gladu, M.P. for Yamaska.

The superficial deposits are here very thick, rock being reached at 172 feet. The find consisted of an accumulation of gas under a bed of impervious hard clay, at a depth of eighty feet. Such deposits are, of course, short-lived at best, but there is little doubt that natural gas exists in the rocks that underlie many parts of the region of the St. Lawrence valley.

Mr. M. E. WILSON continued the examination of the region to the east of Lake Timiskaming, extending the surveys commenced last year to Lake Kipawa and Lac des Quinze. Though the geological formations are nearly identical with those of the silver-nickel-cobalt areas of the Ontario side of the lake, no minerals have been discovered in sufficient quantities to be of economic importance. Large areas of good agricultural land occur in the district and already support a numerous and prosperous farming community.

Mr. W. J. WILSON continued the examination of the country adjacent to the National Transcontinental railway from Bell river eastward to the Susie river. He reports green schists and diabase, probably of Keewatin age, on the Bell river and eastward for some distance. From the lower crossing of the Migiskan river and the National Transcontinental Railway line the rock is gneissoid-granite and gneiss, the latter being well foliated and highly garnetiferous from the headwaters of the Atik river to the Susie river. Small areas of good agricultural land were noted along some of the rivers. The forest in many places was destroyed by fire in 1906.

Mr. OWEN O'SULLIVAN explored the country along the National Transcontinental railway from La Tuque, on the St. Maurice river, to the headwaters of the Gatineau.

Mr. J. A. DRESSER, lecturer in Geology, McGill University, was engaged for three months of the past season in a detailed examination of the serpentine belt of the Eastern Townships of Quebec, with a view of ascertaining the mode of occurrence of the asbestus, chromic iron, talc, and other minerals. In view of the growing importance of this mining district it has been thought well to revise our present economic geology of the entire serpentine belt, and Mr. Dresser's work of the past season was undertaken with that object. He has covered during the present season the immediate vicinity of the principal mines of Thetford and Black lake.

Dr. R. CHALMERS was engaged in a detailed and critical examination of the surface deposits and glaciation of the St. Lawrence valley. The marine shore lines were levelled, and a number of new facts obtained in regard to Post-Tertiary changes of level.

Dr. R. W. ELLS was engaged in New Brunswick for the greater part of the season in tracing out the boundaries between the Upper Devonian and the Lower Carboniferous formations in the southern part of that province, and in an examination of certain Cambrian areas east of St. John. Several mining districts were also visited, and a trip was made to Prince Edward Island in connexion with proposed boring operations there for coal.

Dr. G. A. YOUNG spent the past season in an examination, as far as was possible, of the igneous areas of the Maritime provinces, with a view to their study, in detail, at a later date. He also visited the tin-bearing locality at New Ross, and is of opinion that more prospecting for this mineral should be undertaken throughout the granitic range of Nova Scotia.

Mr. E. R. FARIBAULT completed the topographical and geological surveys of the central part of Lunenburg county, N.S., extending along the Atlantic coast between Chester and Bridgewater. He worked out the detailed structure of the gold-bearing rocks of that region, including the veins operated at Blockhouse, as well as others which are still undeveloped. Extensive beds of gypsum and limestone, unknown until now, have been discovered underlying a thick covering of glacial drift. The deposit of tinstone and other rare and valuable minerals, recently discovered in the granites at New Ross, were examined, and samples were sent here for identification so as to assist as much as possible in the exploratory development of this promising new district.

Last season Mr. HUGH FLETCHER continued his surveys in Nova Scotia, chiefly in the counties of Kings and Annapolis, in the district lying south of the Annapolis valley and forming the part of the South mountain drained by the headwaters of La Have and Nictaux rivers, comprising sheets Nos. 97, 98 and 104.

Mr. Fletcher was assisted the whole season by Messrs. M. H. McLeod and Harold F. Tufts, B.A., and part of the time by W. W. Hughes, who were entrusted with the survey of the headwaters of La Have river, joining on to the south with Mr. Faribault's surveys made the previous summer, and extending west a short distance beyond the Halifax and Southwest Railway line. This region is entirely granite, and is covered with a fine growth of pine and spruce forest, owned for the most part by the Davison Lumbering Company, who have recently built a railway and extensive mills at Springfield, and who are probably doing the largest lumbering business in the province.

Adjoining the granite to the north are the iron deposits of Torbrook and Nictaux, which were fully examined, and the structure of the rocks was made out in detail.

Much of Mr. Fletcher's time was spent at Sydney, in resurveying the structure of the coal basin and tracing the outcrops of the more important seams, to give his evidence in connexion with the lawsuit last summer between the Dominion Coal Company and the Dominion Steel Company.

Mr. Fletcher also re-examined the Sir Wm. Logan's section along the shore at the Joggins, and has prepared a paper on the subject.

He also kept a record of the bore-holes being made at several places to prove the continuity and extension of the coal basins.

Up to the time of writing, Mr. Fletcher's report has not come to hand. Should it arrive in time, it will be printed at the end of this work.

REPORT ON PORTIONS OF THE YUKON TERRITORY, CHIEFLY BETWEEN WHITEHORSE AND TANTALUS.

D. D. Cairnes.

This season was again spent in the Yukon territory, chiefly along the Lewes river between Whitehorse and Tantalus. I was again very ably assisted by Mr. H. Matheson, who did a considerable portion of the topographical branch of the work.

The Yukon territory was reached about May 25, by the usual route via Vancouver and Skagway, and those properties were first visited which had been worked on Windy Arm during the winter. After arriving in Whitehorse and completing the necessary arrangements, we left that town on June 1 and proceeded by canoe down the Lewes river towards Tantalus, having to remain, however, at the upper end of Lake Laberge a few days to allow the remaining ice on the lake to thaw or shift sufficiently for us to get through with our canoe.

Owing to instructions received during the latter part of the season to collect statistical information for the Mines Branch, geological explorations were somewhat curtailed.

The double object of the expedition included further surveys of the coal seams examined last year, some samples of which coked successfully in the laboratory, and of the copper deposits of the Whitehorse district, where successful working is largely dependent on accessible coal suitable for producing a metallurgical coke.

Discoveries of coal were reported at a number of points along Lake Laberge, the Lewes river, and its tributaries the Teslin and Big Salmon rivers. These were examined, as well as the geological formations, generally, along the river to Tantalus.

Except within a few miles of Tantalus, where the Tantalus coal measures cross the river, this so-called coal proved in most cases to be dark or black shales, sometimes more or less bituminous; in other instances the seams of coal, where they did exist, were only a few inches in thickness and of no present economic importance.

AREAS EXAMINED.

Along the river to Lake Laberge, on the lake shores and westward for a few miles, none of the known coal-bearing horizons were met and no coal was seen. The formations here have a general northeasterly and southeasterly trend and the Tantalus coal measures were believed to extend in a southerly direction from Tantalus and to lie to the west of Lake Laberge. A map sheet was therefore projected covering an area about ten miles wide in a north and south direction and extending to the west from Lower Laberge for a distance of about twenty-five miles. The coal measures lie just to the west of this map sheet, but for the reason above mentioned the map was not extended far enough to actually include them.

From Lake Laberge the geological work was continued along the river to Tantalus, after which the auriferous veins and placer deposits of Livingstone creek were examined, as also the reported coal outcrops up Salmon river.

Having arrived at Tantalus another map was commenced which was intended to include the Tantalus and Five Fingers mines and the coal measures in their vicinity. Having completed the work along the river, pack-horses were procured and the survey was continued to the south away from the river.

In addition to the above work quartz properties were examined in the vicinity of Dawson and on Williams creek which enters the Lewes river six miles below Yukon crossing.

TOPOGRAPHY AND FLORA.

The Lewes river between Whitehorse and Tantalus flows in a wide valley having a general north and south trend, and is extremely tortuous in most places, particularly below Lake Laberge, which is a portion of the river that has acquired considerable width and possesses very little grade.

The district examined this season is a typical representative of an uplifted plateau of erosion and is a portion of the Yukon Plateau province. To the west and east, particularly toward the north of the district, there is an abrupt change from the plateau to the mountain provinces of the Coast range and Rocky Mountain range respectively.

To the west of the lower end of Lake Laberge, and about 1,000 feet higher, the valleys, which often contain chains of lakes, are characterized by muskegs. The hills, as a rule, are mostly covered with underbrush and small timber, chiefly spruce, aspen and poplar.

To the north there is a particularly long chain of lakes which is drained for the greater part by Mandanna creek, a stream about four miles long that joins the Lewes from the south, nearly opposite Eagle Nest. The most southerly of these lakes, Frank lake, is over five miles long and has an average width of a mile. One branch of this chain continues west towards Montague on the Dawson-Whitehorse wagon road; the other branch continues about fifteen miles in a direction about S.S.E. The valleys of this portion of the country generally contain lakes of considerable size, and the hills, which are well rounded, are covered with small spruce, poplar, willow, and shrubbery of different sorts. Rock outcrops are very scarce.

Continuing down the river towards Tantalus the hills on the north slopes are chiefly covered with spruce and Banksian pine. Patches of poplars and willow are occasionally seen. The south slopes along the river are more open, some being quite bare; the little timber seen is chiefly poplar and willow. The country farther back from the river here, and that just west of the river between Tantalus and Five Fingers, is practically all covered with spruce, Banksian pine, poplar, and willow, the greater part being spruce. The river flats generally support a growth of poplar, willow and a species of scrub alder.

GEOLOGY.

From the upper end of Lake Laberge to Five Fingers the formations seen are similar to those in the more southerly portions of the Yukon. The oldest rocks exposed are Carboniferous limestones which belong in all probability to the Upper Câche Creek series. Above these are porphyrites, tuffs, tufaceous sandstones, shales, &c., corresponding to the Windy Arm and Tutshi series. Towards the north, however, the porphyrites, tuffs, &c., gradually give place to true sediments. Overlying these latter rocks are the coal-bearing Jurasso-Cretaceous beds, which are buried under more recent sediments and Tertiary flows of lava, &c. Intrusive granites, syenite-porphyrites, and porphyry dikes also occur.

Along the east shore of Laberge the rocks belong chiefly to the limestone series, although some of the more recent rocks, similar to those on the west shore of the lake, are found overlying these unconformably. Along the west side of the lake the rocks, which are chiefly bedded and dip at high angles, are generally coloured tuffs and tufaceous sandstones. These are either finely-bedded or coarse greenish and massive. They are associated with dark, almost black, shaly rocks with occasional brownish bands. Heavy massive beds of very coarse conglomerate also occur, the contained boulders being often one to two feet in diameter. This whole series, lithologically, closely resembles the Tutshi series farther south.

South and east of Lower Laberge are some porpyhrites, porphyries, tuffs, &c., closely resembling the rocks of the Windy Arm series and cut by dikes of typical syenite-porphyry. To the west the outcrops largely consist of coarse, massive beds of conglomerate, from 600 to 700 feet thick, the component pebbles and boulders being chiefly porphyries and granite. Underlying these are thinly-bedded greenish and brownish sandstones and some dark coloured clays. This series is here seen to overlie the limestone series unconformably. Farther west, towards the Whitehorse-Dawson road, there are more tuffs and tufaceous sandstones and shales, generally quite massive, resembling those along the greater part of the west side of Lake Laberge. Outcrops are very scarce in this district.

From Lower Laberge to Hootalinqua the outcrops are chiefly limestone and rocks resembling the Tutshi series.

On the left of the Lewes river, just above Fife creek, conglomerates similar to those at the Tantalus coal mine occur for four or five miles. Though no coal was found here it will probably be discovered in the future. This was the only place at which this formation was noticed along the river until near Tantalus.

West of Salmon river an outcrop of the coast granite was seen, but the greater part of the outcrops here and along the Semenow range consists of generally greenish, fine-grained, and often quite calcareous porphyrites and tuffs. Below Salmon river these porphyrites, &c., continue to near Little Salmon, where true sediments commence. Below Little Salmon river to Tantalus practically all the exposures are limestones or other sedimentaries.

On the right limit of the Lewes river, below Little Salmon, the hills are conglomerate and sandstone to Eagle Nest, which is limestone. Just below, an almost perfect section of the sedimentaries occurring in this vicinity is to be seen unconformably overlying the limestone. Immediately above the limestones are the coarse massive sandstones like those causing the rapids at Five Fingers and elsewhere, and here called the Laberge conglomerate. Overlying these conformably is a series about 1,200 feet thick, which consists of dark shales and lighter coloured sandstones. The dark shale beds which are at times somewhat carbonaceous and contain small areas of lignite, comprise a considerable portion of this series. No lignite seams more than one to two inches in thickness were seen. In addition to these shales there are some thick beds of light grey, yellow and brownish sandstones, the light beds being soft, coarsely bedded and somewhat calcareous. They weather easily and are quite noticeable horizon markers. Some of the beds are more thinly bedded, harder and more siliceous. Remains of tree trunks are of frequent occurrence, particularly in the lighter coloured strata. This whole formation, with the exception of the dark shale bands, presents a coarse-grained, light-coloured appearance. Above this is a reddish series, in the lower portions of which are some narrow seams of lignite on which some prospecting has been done near Eagle Nest. Wider seams may yet be found. These reddish sedimentaries, which are generally coarse-grained, often thinly-bedded and quite calcareous, decompose readily by weathering. A heavy conglomerate bed of the same material occurs near the top of the series here. Though at least 200 feet were observed, the uppermost series were not seen in this section.

These beds in this section outcrop continuously along the river bank to within ten or twelve miles of Tantalus. Their strike is roughly parallel with the river, and the dips being away from the river the outcrop of the different beds shows an apparently horizontal stratification.

Nearer Tantalus are outcrops of the conglomerate formation, or beds, in which the coal at the Tantalus mine occurs. These conglomerate beds are here at least 500 feet in thickness; the top strata in particular shows distinct bedding, the beds being generally two to ten feet thick and very similar in appearance and composition. Chert, black quartz and slate pebbles, apparently derived from the Câche Creek beds, are the chief components. These conglomerates, though not seen in contact with any other formations, are considered to be probably the oldest sediments in the district. Overlying them are some massive, quite coarse, and very light-coloured sandstone beds somewhat resembling the coal conglomerates, but derived, apparently, chiefly from the coast granites.

Extending for several miles along the left limit of the river below Tantalus are basalt, melaphyres, &c., which are very recent and are associated and interbedded with some of the later sediments around the Five Fingers mine and elsewhere. These lavas, &c., are the newest geological formation in this district, except the glacial and post-glacial silts, boulder-clays, &c.

ECONOMICS.

In addition to the districts mapped this season, properties were examined in the following localities: Windy Arm, Livingstone creek, Dawson and Williams creek.

WINDY ARM.

The only properties that have been working on Windy Arm, to any extent, since last season, are the Vault, Venus, and some of those controlled by the Anglo-American Consolidated Mining Company.

Owing to internal dissensions and other causes, the development of the properties on Windy Arm has been much retarded. In most cases the promising properties have continued to improve with development.

Owing to difficulties arising between the owners and the Anglo-American Consolidated Mining Company, work has been curtailed on the claims bounded by the latter.

On the Vault, which has been worked continuously for over two years, a long tunnel is being driven, but the ore had not yet been tapped when the mine was visited about October 1.

On the Venus, approximately 1,800 feet of work has been done this season, with the most promising results. A considerable quantity of ore is blocked out, and one hundred tons shipped to the Tacoma smelter this fall netted over $60 per ton after all smelting charges and deductions were made. The ore is a concentrating one and it is the reported intention of the company to erect a mill on the ground in the near future.

LIVINGSTONE CREEK.

A description of the geology and topography of Livingstone creek is given in Mr. R. G. McConnell's report and map on the 'Big Salmon Gold Fields,' in the Summary report of the Geological Survey for 1901. Since that time the old creek channel has been discovered and is being worked.

The gold is, or was, chiefly in this pre-glacial channel. Since glacial times the present creek has been cutting farther and farther into the thawed south bank, the gravels on the north bank being frozen, so that now, above the canyon near the mouth of the creek, the old channel is on the left limit of the present creek valley. Near Discovery the two channels apparently coincide, and, the present creek having the greater grade has worn down the older channel, into which it has concentrated its values. Above Discovery the gold is practically all in the old channel and is recovered by tunnelling from the present creek bed through the rock rim to the old channel and drifting on it. The pay on the old channel averages about thirty feet in width and two feet in depth, although it is considerably wider in places. There is quite enough grade to the creek for sluicing. The hillside claims, i.e., those on the old channel gravels, have produced, on an average, about $25,000 each.

About $90,000 was taken out of this creek last season and there will probably be over $100,000 taken out this season (1907).

Similar conditions exist on the parallel creeks, Summit lake, Coltoneva and Little Velvet, but owing to scarcity of water only a small amount of work has been done on them. What has been done has given very encouraging results and it will probably pay to bring water from Mendocina creek or elsewhere.

TANTALUS MINE.

Since reporting on this property last season considerable progress has been made. The two main tunnels had, by August 1, 1907, been driven in over 1,800 feet, and twenty-three rooms had been opened up on No. 2 and eight on No. 1 seam.

Five thousand, one hundred and seventy-three and a half tons of coal were shipped last summer, and it is expected that about 9,000 tons will be shipped this summer.

TANTALUS COAL MEASURES.

At Tantalus mine the formations dip to the east and on Tantalus butte, across the river, they dip to the west, showing the presence of a synclinal fold. The continuation of the eastern wing of this fold was noticed about a mile to the east of Tantalus on the left bank of the river. On account of heavy wash the coal is here not exposed, but a small amount of stripping should uncover the seams.

These measures, which cross the river at Tantalus, are known to extend in a northerly direction for several miles at least and in a southerly direction over fifty miles, crossing the Whitehorse-Dawson wagon road seventy miles from Whitehorse. In all probability they extend considerably farther. Throughout a distance of sixty miles they have been traced and wherever a section has been made two or more workable seams of good bituminous coal have been found. In the only places from which it has been obtained at a depth the coal cokes quite satisfactorily.

TANTALUS BUTTE.

At Tantalus butte and just across the river from Tantalus, only assessment work has been done. A section was examined this season and the following seams were measured and sampled:—

		Feet.	Inches.
No. 1	Coal	0	7
	Shale	0	3
	Coal	6	1
	Shale	0	6
	Coal	0	10
No. 2	Coal	9	10
No. 3	Coal	8	10

Three smaller seams, fourteen feet, ten inches and six inches, respectively, were also measured.

All this coal is bituminous and of about the same quality as at Tantalus; when clean it yields a firm, coherent, coke, i.e., if obtained at a sufficient distance from the surface to be free from weathering.

WILLIAMS CREEK.

A number of claims have been staked this season on and near Williams creek. The Bonanza King, which was about the first staked and which was the only one on which any work had been performed, was visited in August. It is situated about one and a-half miles up Williams creek, a stream flowing into the Lewes river about six miles below Yukon crossing.

The ore is quartz, carrying chiefly the copper minerals bornite, chalcopyrite, and malachite. The vein is about six feet wide from wall to wall, including, in this thickness, one to two feet of the country rock. The ore is in a fissure, or fissures, in granite, near its contact with older, much altered diabase, now quite schistose in structure.

When seen, a shaft had been sunk about twenty feet on the ore and a tunnel had been driven about forty feet to cut the vein.

The ore is claimed to carry values in gold, silver and copper; however, average samples obtained by the writer gave only traces of gold and silver and 3·29 to 4·21 per cent copper.

CONCLUSION.

The chief result of this season's geological work has been the locating of enormous quantities of available bituminous coal in this portion of the Yukon territory. Full particulars, accompanied by contoured geological and topographical maps, will be published in the writer's detailed report.

REPORT ON THAT PORTION OF THE COAST OF BRITISH COLUMBIA, EXTENDING FROM POWELL RIVER TO KINGCOME INLET, INCLUDING THE ADJACENT ISLANDS.

J. Austen Bancroft.

The work outlined in the following report is a continuation of that which was carried on by Mr. O. E. LeRoy during the summer of 1906. A week less than three months was spent this summer in actual field operations on the coast by the writer, who had with him a most efficient assistant in Mr. R. P. D. Graham, Demonstrator in Mineralogy at McGill University. That portion of the coast extending from the mouth of Powell river to the entrance of Kingcome inlet was covered, an examination being also made of the islands, within this stretch, between Vancouver island and the mainland.

The general trend of the coast is here N. 52° W., corresponding to a line drawn between these points, and along such a line the distance traversed was 112 miles. An idea can, however, be gained of the irregular nature of this coast by the statement that 1,540 miles of coast were examined, 680 of this being mainland and the remainder representing the extent of shore line presented by the numerous islands. This is as fine an example as exists in the world of a deeply dissected land area which has been submerged. Vancouver island once was connected with the continent, and in the intermediate lowland there then existed at least one or two river systems, receiving tributaries chiefly from the east. Submergence drowned the river valleys, thus accounting for the salt water straits and inlets of to-day, while the many rugged islands represent former inter-stream areas.

During Triassic, and probably late Palæozoic, times this region formed a portion of the ocean floor, and sedimentation was taking place. The latter part of the Triassic was marked by intense volcanic action, probably subaqueous in origin. This history is expressed in the isolated area of argillites, quartzites, and limestones, and the many varieties of volcanic rocks, such as amygdaloidal diabase, porphyrites, agglomerates, and tufas.

During Upper Jurassic times these stratified rocks, which once covered the region, were intruded in a widespread manner by granite and allied rocks. This vast intrusion, known as the Coast Range batholith, is largely composed of granite, but over wide areas it passes into basic facies which are most interesting. Diorites and gabbros are very common, while in Bute and Knight inlets it exists over quite large areas as almost pure hornblende. On a few small islands to the west of Midsummer, and north of Fire island, there is a beautiful development of an orbicular or kugel diorite.

The stratified rocks, then, formed the roof of this batholith. During the intrusion of the latter, portions of the roof were stoped off and engulfed within the magma; others, partially attached to the roof, draped themselves into it as 'roof pendants,' while, in other places, the stratified rocks may have been actually folded into the magma. Especially up the deeper inlets, that is, towards the axis of the Coast range, the granite is locally gneissoid, and a schistose structure has been developed in some of the areas of stratified rocks. The strike of such gneissoid and schistose structures corresponds in general with the axial direction of the range. Two sets of dark dikes have cut the region since the cooling down of the batholith.

To-day, erosion has removed the roof, with the exception of a few isolated patches, and has truncated the included stratified masses. It is exceedingly important that these scattered areas of stratified rocks be located and mapped, for it is within them, and especially along their contact with the intrusive batholith, that the prospector should look for minerals of economic value. Within the region examined about fifty areas of such rocks were located.

Though only one fossil specimen had hitherto been found within the whole of this area, we were fortunate enough to discover five localities that contained among them at least four species.

About thirty-five prospects were visited during the course of the summer. South Valdez island was the only locality where mining operations were being carried on in the district at the time of visitation. From Kelly point to Quathiasca cove this island is underlaid by volcanic rocks. These represent a portion of one of the roof remnants of the batholith. Once floating on the plastic magma, during the adjustment upon cooling down, small faults formed in these volcanics. Heated waters and vapours passing up the fault and joint-planes deposited copper minerals along these cracks, and where the adjacent rock was very porous, because of its amygdaloidal character, it became impregnated, chiefly with chalcocite, and with less quantities of bornite and native copper. This accounts for the stringers of chalcocite along a zone of shearing in the Ajax claim, situated on the north of Deepwater bay (at an altitude of 950 feet above sea-level and about one mile from the shore), and for the irregular vein on 'The Ingersoll,' situated about two miles from Copper Cliff. On 'The Ingersoll' a very irregular vein of chalcocite with a gangue of calcite and quartz may be traced for 350 feet with a maximum width of fifteen inches, the country rock being unevenly impregnated for a width of thirty-four feet. The Copper Cliff, Commodore, and Steep Island mining properties are situated on highly amygdaloidal beds through which are disseminated over wide areas, chalcocite, a little native copper, and, on the Commodore, some bornite.

From Open bay, on the east of South Valdez island, to within a mile and a half of Granite bay on the west side, there extends a series of limestones and interbedded greenstones having a maximum width of a little over a mile. In this area, which deserves the most careful prospecting, a number of claims have been located. On the 'Lucky Jim,' along a contact between the limestone and a greenstone layer, chalcopyrite, pyrrhotite, pyrite, and some magnetite have been deposited. On 'The Geiler,' a shaft twenty feet deep sunk on a similar contact, displays a very good showing of chalcopyrite. A speck of free gold was noticed in a specimen taken from "The Geiler.' This area is, of course, not yet sufficiently examined to properly determine its possibilities, for at no point has it been opened up to a greater depth than twenty-five feet.

On the north of Rodonda island the Elsie claim is staked on a deposit of magnetite that occurs at a contact between the granite and a patch of marble. At an altitude of 500 feet, one open cut has exposed fifty-four feet of magnetite, with a width of thirty-five feet, and at two other points smaller amounts have been uncovered. This property should be tested in depth for the ore is high grade and shipping facilities, although the ascent from the water is steep, could be quite easily arranged.

The Shoal Bay area, which is now deserted, is associated with contact phenomena between the granite and stratified series.

On Mars island, to the southwest of Baker island, small quantities of bornite and galena were found in a limited area of argillites and limestones. On one of the joint planes of a quartzite layer flecks of leaf gold were seen.

On the northwest of Village island, in another area of argillites, a small amount of chalcopyrite and bornite was noticed.

Granite, suitable for building stone, may be found at a number of different localities with excellent opportunity for immediate shipment by water. At Squirrel cove, Walsh cove, towards the head of Pendrell sound, and at Kwatsi bay, the granite affords such commercial possibilities. The area of orbicular diorite above mentioned would furnish a unique and very beautiful ornamental stone.

In certain depressions on South Valdez island, Manrelle island, and especially Reade island, the finer grained glacial clays should make excellent material for the manufacture of bricks.

An examination was also made of a hematite deposit, owned by Mr. Stuart Henderson, M.P., of Ashcroft, a detailed report of which will be rendered shortly.

THE BULKLEY VALLEY, B. C.

W. W. Leach.

According to instructions work was continued in the Bulkley valley and vicinity during the past season. The topographical map, compiled last year, and now in the engraver's hands, was used as a base, being extended both to the north and south, but chiefly to the north, including the Bulkley valley as far as Moricetown, the Hudson Bay mountains and the headwaters of the Zymoetz (Copper) river, as well as some work done on the head of Paint creek and the Morice river.

A carefully made transit and chain traverse was run from the town of Telkwa to Moricetown as a check on the triangulation of last year.

The season, on the whole, was unfavourable for topographical work, a late wet spring being followed by an exceptionally dry, hot summer, with, as the result, many forest fires and a dense smoky atmosphere during the short season in which work is possible in the higher mountains.

The greater part of the season was spent in the upper part of the Telkwa river and the country lying between that river and the Zymoetz; this district has been very little prospected and the absence of trails made progress slow.

TOPOGRAPHY.

The Telkwa, above the south fork, occupies a wide, flat valley, the river meandering through swampy meadows; its course here is approximately northeast and southwest. About twelve miles from the south fork, near Mill creek, the valley turns sharply to the south and at the bend an unexpected and low pass leads off to the west to Summit creek, a branch of the Zymoetz; this pass may be of great importance, for it has been occupied by one of the several surveyed lines of the Grand Trunk Pacific.

Milk creek rises in a high and rugged range of mountains forming the divide between the Zymoetz and the Telkwa rivers; this range rapidly decreases in height to the eastward, forming a plateau-like country, where the highest point reaches an elevation of only 6,600 feet, finally dropping down to a low pass, in which Pass creek rises, and which separates it from the Hudson Bay mountains.

The last named range though quite rugged, the highest points reaching at least 8,000 feet, is cut off on all sides by low country and, therefore, forms a very conspicuous feature of the district.

In most cases the headwaters of the Zymoetz occupy wide, flat valleys interspersd with many small lakes and much meadow land.

The country, as a whole, with the exception of the Coast range, is characterized by a series of isolated groups of mountains surrounded by low valleys in which the river and creek systems have little regularity.

GEOLOGY.

By far the greater part of the country traversed is underlain, as described in last year's report, by rocks of the Porphyrite group, mainly composed of andesites, tuffs, and agglomerates and almost entirely of volcanic origin.

From the head of Milk creek westward the rocks, which are all of the Coast crystalline series, have not been studied in detail, no minerals of economic importance having yet been discovered in them.

The most important rocks, from the miner's point of view, are those which have been called 'the later eruptives,' as all the important mineral discoveries of the district are situated in the volcanics near their contact with these rocks or in or alongside dikes from their main bodies. These eruptives have also had an important influence on the quality of the coal. They constitute the youngest rocks of the country, cutting both the volcanics and the coal formation, and are found usually either as a pinkish syenite porphyry, or as a light greyish granite porphyry, the dikes from them varying greatly in appearance.

Two important areas, one on Scallon creek, the other at the head of Glacier creek, were referred to last year. Another small area was noted on the ridge between Morice river and Goldstream, and yet another near the head of the north fork of the Telkwa; little or no prospecting has been done in the neighbourhood of either. A large area of these eruptives was found on the western ridges of the Hudson Bay mountains. This locality has received much attention of late and many mineral claims have been located.

MINERAL CLAIMS.

Immediately on arriving at Telkwa (at the mouth of the Telkwa river) a short trip was made to Hankin's camp, situated at the head of Goat creek, where a group of claims have been located by Messrs. Loring, Forrest and the Hankin Brothers. These are among the oldest mineral locations in the district, and a good deal of prospecting, consisting of open cuts and several short tunnels, has been done on them.

The country rock consists of typical beds of volcanics, tuffs, agglomerates, andesites, &c., belonging to the Porphyrite group and here lying nearly horizontal and well exposed at many places on both sides of the rather deep, narrow valley. These beds are cut by a number of roughly parallel, light-coloured quartzose dikes with a nearly vertical dip and crossing the valley approximately at right angles.

The mineral deposits occur in nearly horizontal beds following the bedding planes of the volcanics and show decided enrichment in the immediate vicinity of the dikes; the mineral bearing solutions have apparently ascended along the walls of the dikes and thence, following the bedding planes, have decomposed the more readily attacked volcanic beds.

On the 'Eldorado,' 'Naiad' and 'Telkwa' claims the best showings of mineral are to be met with; here at least two beds of ore, each about five feet in thickness, may be seen, consisting of iron pyrites, copper pyrites, a little pyrrhotite, and magnetite, in a gangue of altered country rock, epidote, quartz &c. The percentage of copper is small, but, according to the owners, fair values in gold are to be found. The ore bodies are very much thicker in places, more particularly immediately alongside of the dikes.

Many of the claims on Howson creek were described in last year's Summary, but this locality was again visited this year, considerable development work having been done and various new claims located.

At the 'Evening' claim a cross-cut has been run for seventy feet in low grade ore, the main body, exposed by cuts on surface, not having been yet reached.

On the 'Duchess' a tunnel has been driven for sixty feet, starting at a very good exposure of copper ore and following the foot-wall of the ore-bearing dike. The ore is continuous for the length of the tunnel. Several open-cuts have been made up the hill on what is supposed to be the 'Duchess' dike; one of these shows six feet of good ore, the others very little, but the dike is much decomposed and iron-stained.

There are a number of parallel dikes here, some of them ore-bearing, which have a general north and south strike, about at right angles to the direction of the valley. As the ground is mostly drift-covered, and the dikes are often quite close to one another, it is a difficult problem to ascertain, for any distance, which dike one is following.

The 'Countess' claim, owned by the same company as is the 'Duchess' (The Telkwa Mines, Limited), is situated near the top of the ridge on what is probably a similar and parallel dike. An open cut has been made here, but not much ore is in sight; a small cut, however, on the same dike at the top of the ridge has a much better appearance, the ore there being similar to that at the 'Duchess.'

Across the ridge, to the north, in a small basin in which rises a branch of Howson creek, a number of claims have been staked. Among these the 'Standard,' 'Princess' and 'Contention' are also owned by the Telkwa Mines, Limited; on only one of these, the 'Standard,' was any work seen. It consisted of a small open cut showing from eighteen to twenty inches of good ore, composed of chalcopyrite and specular iron with a little quartz. The ore occurs in a dike along the hanging wall.

In this basin, as at the 'Evening' and 'Duchess,' a number of parallel dikes occur, with approximate north and south strikes and cutting the bedded volcanics; the ore is found in the dikes, usually near the walls, and at times extends into the country rock.

The Telkwa Mining, Milling and Development Company have also a number of claims here, among others the 'Whispering Wind' and 'Silver Heels.' On the latter a large dike from fifty to sixty feet wide exists, striking north and south and dipping 75 to 80 degrees east; on the easterly or hanging wall about four feet of chalcopyrite and specular iron ore was seen, but no work has been done; on the westerly wall, however, a large open cut shows fifteen feet of good ore consisting of chalcopyrite, specular iron, and a little iron pyrites with a gangue of quartz and altered country rock.

On the south side of Howson creek a number of claims owned by the Telkwa Mining, Milling and Development Company were visited, the most important being the 'Walter,' 'Iron Colt,' 'Granville,' 'Strathcona' and 'Anna-Eva.' All of these were seen last year, and little has been done since. The ore occurs in dikes from the large porphyry area on Scallon creek cutting the rocks of the Porphyrite group, and is generally much decomposed. A sample of black, earthy material from the 'Strathcona' was found to consist of oxides of copper, manganese and iron.

Most work has been done on the 'Anna-Eva,' an open cut over 150 feet in length having been made across the face of the dike. The mineralization is irregular and not very heavy, and the whole dike is much decomposed, the ore consisting of copper carbonates, chalcopyrite, iron pyrites and specular iron. A short distance to the south, on top of the hill, where the ground is heavily drift-covered, a new cut had been started, showing much higher grade ore, chiefly chalcopyrite and specular iron with a good deal of quartz, across a width of about twenty-five feet.

The Hudson Bay mountains were visited late in the summer, but as all the prospectors had left for the season, it was almost impossible to find where the chief claims were situated. However, a few were seen.

At the head of Lyons creek, on the eastern slope of the range, two claims, the 'Copper Queen' and 'Iron Mask' are near the edge of a small granite area cutting the volcanics, and the mineralization appears to follow the bedding of the decomposed andesites. The ore consists almost entirely of arsenical pyrites in a quartzose gangue, but not enough work has been done to show the extent of the deposit. A specimen of this ore gave by assay: gold, $8; silver, 0·52 ozs. to the ton.

About one mile down Lyons creek, on the south side, some work had been done, but the name of the claim could not be ascertained. The ore occurs in a large dike, about seventy-five feet wide, near the hanging wall, and shows about three feet of fairly well mineralized material consisting of arsenical pyrites, some copper carbonates and a very rusty quartz in bands parallel to the dike wall.

On the western slope of the mountains, near the head of a small stream running into the Zymoetz river, the 'Tower Hill' claim is situated. The country rock here. consisting chiefly of red and greenish andesites, has been tremendously disturbed, and some splendid samples of folding on a large scale may be seen. A number of open cuts have been made in what appears to be a thin bed of greenish andesite, much altered and containing some copper carbonates, a very little bornite, some quartz, calcite, epidote, &c.

There are said to be other and better showings in this neighbourhood, but the writer was unable to find them.

COAL.

During the past year practically nothing has been done on the coal properties of the Kitimat Development Syndicate, the Cassiar Coal Company or the Transcontinental Exploration Syndicate, all situated on the Telkwa river or on Goat creek, one of its tributaries. Until the route of the Grand Trunk Pacific railway is finally decided on it is not probable that much development will be undertaken.

On the property of the Telkwa Mining, Milling and Development Company, located on Coal creek, at the headwaters of the Morice river, a little exploration work has been carried on, and the limits of this are fairly closely defined. Although the area is small the coal is of very high grade, as the following analyses show:—

All Non-Coking.	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
1.—5 ft. 6 in. seam	1·36	10·87	80·82	6·95
2.—7 ft. 3 in. seam	0·80	11·10	78·90	9·20
3.—4 ft. 0 in. seam	0·58	10·80	82·70	5·90

The anthracitic quality of this coal may be explained by its contiguity to two areas of later eruptive rocks, one at the head of Glacier creek and the other on the north side of Goldstream, and to the great heat and pressure consequent on their intrusion.

On Goldstream, a little below its junction with Coal creek, and separated from the above area by a short distance only, a new coal area was discovered this year. This area, about two by two miles and one-half, at its greatest diameters, is in the form of a basin, the coal outcropping on both sides of, and from 400 to 500 feet above the floor of, the valley. The coal dips towards the creek from both sides with a slope rather greater than that of the hills, so that it underlies the bed of the stream, although at no great depth.

Up Goldstream this area is separated from that on Coal creek—probably by an anticline, the coal measures having been removed from its axis by denudation. At the lower end the limits of the coal-bearing strata are not so clearly defined, but, in all probability, the creek has there cut through the coal measures to the underlying volcanics, this cutting being accentuated by another anticlinal fold.

The coal has been opened up at only one place, where two seams have been uncovered, the upper one showing five and one-half feet of clean coal overlain by about one and one-half feet of soft impure coaly material, the cut not having been extended far enough to locate the roof clearly. The lower seam shows three and one-half feet of clean bright coal. No analyses have as yet been made of these coals, but in appearance they closely resemble the coal from Coal creek, analyses of which have been given above. At several other points across the basin the coal outcrop was noted, but no time was available to open up the seams.

No evidences of local disturbances or faulting of any great extent were noted.

Another and smaller area was seen about two miles farther down Goldstream, but has not been opened up.

Other areas of the coal-bearing rocks were noted at Driftwood creek, Moricetown, at the head of the Zymoetz river, and on Hudson Bay mountain, but at none of these localities has any workable seam been yet found, and it seems probable that the seams reach their maximum thickness in the Telkwa-Morice River district, and thin out rapidly, at least towards the north.

It is now fairly certain that no great coal field exists in the Bulkley Valley district from Hazelton to the headwaters of the Morice, but many comparatively small, isolated areas are known in which the coal varies from a lignitic to a semi-anthracite. In some of these areas the strata are greatly disturbed, much faulting and folding being in evidence.

The quality of the coal seems to depend on the proximity of the measures to the newer eruptive rocks which are younger than the coal, and in places have sent out dikes cutting the seams.

A number of fossils were collected from the coal measures and adjacent beds ; although none of these have as yet been determined, there is sufficient evidence to state that these rocks are probably Lower Cretaceous, though possibly Jurassic.

CAMP HEDLEY, OSOYOOS MINING DIVISION, B.C.

Charles Camsell.

The important mining camp of Hedley is situated on the north side of the Similkameen river, at the mouth of Twenty-mile creek, in the Osoyoos mining division of British Columbia. It comprises about 100 surveyed and Crown-granted mineral claims, and many others on which the annual assessment work is still being done, all covering a sheet of about twelve square miles. It was discovered in the year 1896, when nine claims were staked on the ground overlooking Twenty-mile creek. Each succeeding year found more and more prospectors impressed with the possibilites of the camp, and more claims were taken up, until in 1900 virtually all the ground now included in Camp Hedley was staked out. The largest property owners in the camp, the Yale Mining Company, were early on the ground and commenced the work of prospecting their most important claims early in 1899. The preliminary work undoubtedly proved satisfactory for they shortly after showed their faith in their prospects by beginning the building of a tram line, flume and stamp and cyanide mill, a work entailing the outlay of hundreds of thousands of dollars. Though it is a little more than three years from the time the first ton was milled, and the ore is extracted from only two claims, the camp has since justified their faith in it by becoming the largest producer of gold alone of any camp in British Columbia. It is very probable as development goes on and transportation difficulties are overcome new ore bodies will be discovered and other known ore bodies of lower grade will be worked, for the history of mining is only now beginning in this portion of the Similkameen district.

As the only previous work done in this neighbourhood was the reconnaissance of Dr. Dawson in 1877, when there was not the slightest suspicion of such valuable ore occurring, it will be readily seen how urgent was the need of the work of a Geological Survey party.

The field work of the season was in part devoted to the acquiring of data for a topographic map of the camp, which will cover, when completed, three miles from east to west, and four miles from north to south. The scale on which this is being prepared is 1,000 feet to the inch, with a contour interval of 100 feet. Geological studies were carried on at the same time in conjunction with the topographic work, and special attention was paid to the occurrence of the ore deposits, their origin and history; but the attempt to do both simultaneously and with the same party was responsible for neither being finished at the close of the season. Much credit is due for their zeal and co-operation to my two assistants, Messrs. J. A. Allan and A. O. Hayes, who, besides assisting in the geological work are to be credited with a great deal of the topography.

The method employed in mapping the district was that suggested by Mr. W. H. Boyd as likely to give the greatest accuracy for the time and means at hand. Triangulation on signals from an accurately measured base gave a number of fixed points on the sheet. Traverses were run with transit and stadia of all the wagon roads in the district, as well as most of the trails, the tram lines and flume; and the detail was filled in with the plane table and stadia-readings. Elevations were obtained from a Canadian Pacific Railway bench mark corrected to sea level. This gave the town of Hedley as 1,620 feet, and the highest point in the sheet as 6,660 feet above sea level. The unfinished portion, which covers the northwest quarter of the sheet, is much too rough and steep to be done in this way, and will have to be done by photographic surveying.

The work was also considerably facilitated by the interest taken in it by many of the people of the district. The Daly Reduction Company, through their manager, Mr. Ross, placed every convenience in our way, and the use of the gravity tram saved much time and hard labour. And of those to whom I am particularly indebted for information I may mention Messrs. F. M. Wells, C. E. Oliver, J. Gladden, A. Megraw; as well as the officials of the Yale Mining Company and the Daly Reduction Company.

TOPOGRAPHIC FEATURES.

Camp Hedley lies on the western side of the Okanagan range of mountains, whose highest points here reach an elevation of a little more than 7,000 feet above sea level. The neighbouring country is characterized by comparatively rounded outline and moderate relief to the east and south, but the northwestern portion lies in the deep and narrow canyon of Twenty-mile creek, where extremely rugged and precipitous conditions prevail. The part of the valley of this creek which lies in our map is V-shaped, and about 4,000 feet in depth. The slopes on either side are very steep, and frequently impossible to climb. Broken rock talus slopes topped by precipitous bluffs are everywhere very common, while the narrow box-canyons cut by the torrential streams in the mountain side are nothing more than mere gashes almost imperceptible from the opposite side of the valley. These canyons are frequently the only possible means of ascending or descending the mountain side ,while the ridges between them are quite impossible to explore.

The action of erosion in this canyon is very strong, and is equal, if not in advance of, the decomposition of the rocks by oxidation, and the finding of secondary surface deposits of oxidized ores is not to be expected where such conditions prevail. Every shower of rain throughout the summer washes down the canyon sides masses of rock that only a little undermining was sufficient to dislodge, so that the Daily Reduction Company, whose flume runs for three miles through the canyon, have to keep men on the watch night and day to guard against or repair accidents from falling rocks. Drift does not cover the rocks in this section, so that in its accessible parts the geological relations are easily studied.

On the slope of Eighteen-mile creek and overlooking the Similkameen river the physical features are not so bold, and the conditions are not unlike those which hold over the rest of the Interior Plateau. This part is not heavily wooded and the southern faces are usually devoid of all timber. The slopes are not so steep that drift will not rest, and unless exposed by the pick and shovel of the prospector outcrops of rock are rare. The prospector who owns claims on this side of the hill is likely to incur a great deal more expense in prospecting, and he is also more likely when he does locate an ore body to find it very much more oxidized and enriched on the surface than in the Twenty-mile canyon.

For the diversity of physicial conditions on the two sides of the hill, one must look to glacial causes. Looking at the valley of the Similkameen river from the top of the gravity tram line, and particularly to the southward, one is at once struck by its glacial outlines. The steep sides and broad drift-filled bottom make a well-defined U-shape that is characteristic of all valleys modified by the scouring action of a glacier. Typical also are the many hanging valleys that may be noted on the south side. Henry creek, Susanne creek and John creek all steepen suddenly in grade on approaching the main valley, and have not yet had time since the disappearance of the glacier to carve out a valley of uniform grade. The deep canyon of Twenty-mile creek may be also attributable to the same cause. The retreating glacier which filled the Similkameen valley eventually left the Twenty-mile creek occupying a hanging valley and emptying into the main valley by a short steep fall at its mouth. While the smaller streams were unable in the time since the disappearance of the glacier to cut down their valleys, Twenty-mile creek, with its larger volume and greater erosive power, was able to deepen its own bed in the rock and to form its present V-shaped valley. In this work it may have been materially assisted by taking advantage of the numerous faults and fractures that are found in these rocks, and which are the results of many and long-continued periods of vulcanism. The only other way to account for this Twenty-mile canyon is by a recent uplift of this portion of the earth's crust, of which there is not any corroborative evidence to be found in the surrounding country.

The whole Camp Hedley area was covered by ice during the glacial period. Though glacial striae were never noted, boulders transported by glacial action are found scattered over the summits of its highest hills.

GENERAL GEOLOGY.

The geological history of the area is somewhat complicated, and while the general sequence of events has been roughly worked out, there are yet many details which will require more study both in the field and in the office.

From the time its first sediments were laid down in the sea, the region has been the scene of much volcanic activity. Igneous rocks of different kinds have been instrumental in altering the older rocks, so that now it often is impossible to state definitely whether some of these older rocks were originally igneous or sedimentary.

The oldest rocks are the sedimentaries that cover the greater proportion of the surface. They all belong to one series, and have been referred to the Câche Creek group of Dawson's classification. No determinable fossils have yet been found in them, but the lithological characters of the strata are very similar to the original Câche Creek rocks first described farther to the north.

These sediments are of great thickness, and as their prevailing dip is towards the west, a section from east to west across the sheet would give the succession in ascending order. This east and west section shows the following:— (1) red, grey and some black argillaceous and siliceous beds interstratified in thin bands; (2) blue and white limestone, much altered and crystalline, with some siliceous beds and breccia; (3) argillaceous and siliceous beds on the west side of Twenty-mile creek and extending some distance beyond the limits of the sheet. Interbedded with these are a great number of sheets of andesite highly mineralized with arsenopyrite and weathering to a reddish colour that gives to the sides of the mountain the beautifully banded appearance which evoked the name of Striped mountain from Dr. Dawson.

All of these beds have been more or less altered by igneous intrusions, but those which have suffered most are the calcareous ones of the middle division. This division has also proved the most congenial for the formation of ore deposits, for in it lie the two producing claims on the hill, the Nickel Plate and the Sunnyside. The beds in which the ore bodies of these two claims occur have probably been originally limestone beds which become more or less impure towards the top, and near the contact of the igneous rocks have been altered by the addition of more silica to a rock made up largely of epidote and garnet with quartz and calcite. In other parts the alteration has been to pyroxene, or again to actinolite, but always with more or less garnet, epidote and calcite, depending upon the purity of the original beds. Irregular bodies of cherty rock are also frequently found in the contact metamorphic zone. About the centre of the sheet, in the P.S. draw, the alteration of the sediments has been to a rock made up almost entirely of garnets and which is called garnetite. In portions of the Nickel Plate mine the metamorphosed rock has a distinctly banded appearance due to the alternations of epidote and garnet in thin layers. Arsenopyrite is always a constituent of the contact metamorphic zone except where the igneous rock is granite. The monzonite and all its offshoots contain this mineral, and from them it migrated to the sediments.

The sediments on the eastern edge of the sheet are nearly horizontal. At the Nickel Plate mine they dip about 20 degrees to the west, but gradually steepen on the west side of the hill to 35 and 40 degrees. Across Twenty-mile creek and westward the angle of dip increases until it reaches 90 degrees, and the strata become closely folded and compressed.

Some volcanic activity probably took place while the rocks were yet beneath the sea which would account for the interstratified beds of breccia and of possible tuffs. Numbers of andesite sheets were injected before the sediments were folded as they now are, while other dikes of the same material could only have been injected after the folding took place.

The rock next in age to the sediments is a mass of monzonite forming a core nearly in the centre of the camp, and extending to the west side of Twenty-mile creek. The normal phase of this rock is rather basic in composition, and is made up of orthoclase and plagioclase in about equal proportions, much hornblende and some augite, biotite and quartz. A more acid rock, containing none or few of the dark coloured constituents, lies to the east of this and forms the very prominent Climax bluff. Each of these rocks sends off innumerable dikes and sheets of so-called andesite into the surrounding sedimentary rocks. The relation of these two rocks to each other is puzzling. Well marked contacts between the two are sometimes found, and these invariably show the acid rock to be the more recent. Apophyses of the more acid rock are also found in the basic. On the other hand, gradual transitions from the one to the other are frequently seen, and wide areas occur which appear to be intermediate in composition between the two extremes. Altogether it is probable that the two varieties were derived from the same magma, though their formation of crystallization may not have been contemporaneous. If not contemporaneous then the acid variety is later in age than the basic. The coarseness and evenness of the texture show their plutonic origin and that their crystallization took place far below the surface.

The dikes and sheets derived from this monzonitic core are also of two varieties, and show much the same composition as the mass, but with the development of a porphyritic structure. The acid variety appears to be more often connected with ore deposits than the basic.

Later than the monzonite is a large batholithic mass of granite, which forms the base of the hill overlooking the Similkameen river, and extends eastwards across Eighteen-mile creek. This granite is similar to the large area of granite through which the river cuts for fifteen miles between Hedley and Princeton, and is probably part of the same intrusion, though separate for a short distance from it. It holds both orthoclase and plagioclase, with quartz, hornblende and biotite. A dike-like mass as an offshoot from this, 100 to 400 feet wide, is connected with the main mass on Eighteen-mile creek and runs diagonally across the hill to a point on Twenty-mile creek one mile above the town. The composition of this dike is slightly different in that the hornblende is almost entirely replaced by biotite. Overlooking the Similkameen river the granite is in contact with the older sedimentary rocks, and this contact shows the granite truncating at an angle of about 30 degrees the edges of the sedimentary strata as well as the andesite sheets that are interbedded with them. The granite-monzonite contact on the Kingston draw shows many inclusions of monzonite in the granite, as well as apophyses of the granite in the monzonite.

Quartz porphyry and aplite dikes that cut both the granite and the sediments in several places are probably to be referred to the final stages of the granite intrusion.

A number of dikes of different composition follow the granite intrusion. Of these the most important are black and fine-grained, and are found in the northern and eastern parts of the sheet. They appear to radiate from a common centre near the foot of Bradshaw canyon. The texture of these dikes is felsitic, and in colour dark and reddish. For convenience it is called a felsite. It is rather siliceous and like the monzonite contains much arsenopyrite. Segregated masses of this rock are met with in the monzonite apparently as a product of differentiation of the magma, showing that the two rocks are genetically connected, and under certain conditions the one might pass into the other.

The latest rocks in the camp are dike rocks, lamprophyres, rhyolites and soft green dikes. These, like the granite, appear to be barren of any arsenopyrite, and are not associated with the ore bodies except perhaps accidentally.

ECONOMIC GEOLOGY.

Camp Hedley up to date is entirely a gold producer, though it gives promise of some copper production later on.

The ore deposits belong to the class known as contact metamorphic deposits, that is to say, deposits that occur as the result of metamorphism of sedimentary rocks by igneous intrusions. The principal ore mineral is arsenopyrite, and the deposits are unique in the respect that arsenopyrite has never hitherto been found in such proportion to the other sulphides in contact deposits of this kind.

The ore bodies lie in the sedimentary rocks and particularly in the second division of the section already mentioned. The large eruptive mass of monzonite lying nearly in the centre of the camp has itself been the cause of intense contact metamorphism in the sediments that it cuts. Moreover the large number of dikes and sheets of andesite which had their source in the monzonite are also responsible for a great deal of local metamorphism. It is along the contact of these igneous rocks and in the zone of contact metamorphism that ore bodies have been found. Primarily these igneous rocks may have been responsible for the introduction of the values, but other causes have been instrumental in concentrating these values to render them economically important.

The granite is not important in this connexion, while all the dikes have not been sufficiently studied to justify an opinion as to what influence they have exerted in the formation of ore bodies.

The more acid variety of monzonite, and the sheets which it gives off, have caused, as a rule, the most intense contact metamorphism in the intruded rocks, and apparently the payable deposits are more generally associated with this variety.

The sphere of influence of the monzonite core with its dikes and sheets covers the whole camp, but the action becomes feebler at a distance. Where the sediments have felt the direct influence of the mass the alteration has been extreme, and whole areas of what were originally calcareous rocks have been altered to garnetite.

The zone of metamorphism in the sediments varies largely with their composition and the angle at which they are cut. The calcareous rocks lend themselves more readily to metamorphism than the siliceous or argillaceous rocks. They are also more congenial for the formation of ores. Both in the Nickel Plate and Sunnyside mines the ore bodies lie in what were originally limestones, the Nickel Plate stratum having been more impure than the Sunnyside.

The contact metamorphic minerals developed in the sediments are garnet, epidote, calcite, pyroxene and actinolite, and with these are associated as ore minerals arsenopyrite, pyrrhotite, chalcopyrite, pyrite and specularite. The association of the oxides with the sulphides shows that they must have crystallized out under considerable pressure. Irregular bodies of hard cherty rock also occur near the contact, and probably owe their origin to an introduction of silica from the igneous rock.

Though the gold is always associated with the arsenopyrite, a great deal of arsenopyrite occurs scattered through the metamorphosed rock in which very little gold is found. It is almost impossible to tell, except by assay, what the value of the ore will be, for it all looks very much alike.

As a rule pyrrhotite is not associated with high gold values. Specularite, however, is a good indication. Chalcopyrite is common, though rarely in such quantities as to become important as an ore of copper. On the Warhorse mineral claim chalcopyrite occurs associated with pyrrhotite in sufficiently large bodies to make this claim a promising one, particularly as the ore also carries some values in gold and silver. Pyrrhotite is found massive on the Toronto and Galena workings and probably as a product of magmatic differentiation. On the Red Mountain it occurs in such quantities as to make the compass absolutely useless for surveying.

The Yale Mining Company own some twenty-five claims in the camp, of which only two, the Nickel Plate and the Sunnyside, are being worked at present. The ores from these claims are treated by the Daly Reduction Company in a 40-stamp mill and cyanide plant in the valley below. The capacity of this mill is about 3,500 tons per month. The mine and mill are run by water power obtained from a flume three miles long. The company own an electric tram line about a mile and a half long to carry the ore from the mine to the tipple, and a gravity tram line of 9,500 feet in length and 3,500 feet vertical height, which carries the ore in five-ton skips to the mill.

The Nickel Plate and the Sunnyside are the most important claims in the camp, and up to the close of 1906, or in less than three years, have turned out over 77,000 tons of ore. The Nickel Plate ore body lies in altered sedimentary rocks, which dip about 16 degrees to the west. Interbedded with these or cutting them at an angle are intrusive sheets of andesite. A vertical quartz porphyry and a black dike cut all these strata. The ore body now being worked lies on the upper side of a large andesite intrusion, which dips 40 degrees to the west and cuts the sediments at a sharp angle. The andesite acts as the footwall, and the ore body lies in the sedimentary rock in the zone of contact metamorphism due to the andesite intrusion. The metamorphosed rock consists of garnet, epidote and calcite carrying much arsenopyrite. The richest ore lies on the footwall and gradually fades out on the upper side into low grade rock. The greatest width of the pay ore is about eighty feet. The ore body is bounded on two sides by dikes and the third side by a zone of fracturing running across the hill. Both arsenopyrite and pyrrhotite occur, but the gold is always associated with the former mineral and the greater the mineralization by arsenopyrite the higher the values in gold.

The Sunnyside claim adjoins the Nickel Plate on the south and the ore body lies in a lower stratum. In all four workings the ore body always lies in altered limestone at or near the contact of an andesite sheet or dike. Epidote and garnet are not so abundant as in the Nickel Plate, but there is more calcite, quartz and pyroxene, all of which are more highly developed. The rock is very porous and has been much fissured, the fissures being now filled with calcite. Specularite is found in most of the Sunnyside workings, particularly on the footwalls.

In each of these claims the andesite sheets play an important part, and with other cross-cutting dikes have been the cause of confining the high values to certain restricted areas. Whether these igneous rocks are responsible for the introduction of the gold in the first place is uncertain, but the later concentration required the peculiar physical conditions that are now found in each of these claims. And in the search for other ore bodies in this camp, the apparently accidental conjunction of dikes and of dipping strata such as are here found should be borne in mind.

The Kingston group of mineral claims consists of the Warhorse, Kingston, Metropolitan and the Kingston Fraction, all lying on the Twenty-mile slope of the hill. The Warhorse ore body lies on a contact of massive blue limestone with an andesite sheet, and not far from the central core of monzonite. The limestone dips 30 degrees to the west, and carries irregular masses of cherty rock. It is cut by irregular dikes of andesite, which alter the limestone to an epidote-garnet-calcite rock. This constitutes the gangue of the ores, and the ore minerals are pyrrhotite, chalcopyrite, arsenopyrite and galena. These are scattered through the gangue in varying proportions, pyrrhotite forming with chalcopyrite the largest percentage. The chief values are in copper, but this is supplemented by some gold and silver.

On the Kingston claim farther down the hill the workings are in the sediments within a few feet of the edge of the monzonite core. Injections from the monzonite have penetrated the bedding planes of the sediments, altering and mineralizing them as in the case of the Nickel Plate mine. The chief values are in gold, which is associated with arsenopyrite. Some later dikes cut both the sediments and igneous rocks, forming favourable localities for the concentration of the gold by circulating waters. The Kingston group of claims is very favourably situated for the occurrence of ore bodies, and more extensive development may prove their existence.

It was possible to examine only a few of the many claims in the camp, and only those on which some development work had been done. A group in the northern part of the sheet, owned by T. Bradshaw and others, gives promise of containing some valuable bodies of ore. Besides this there are many other claims, which with cheaper transportation and better facilities will be worked to advantage.

THE LARDEAU DISTRICT, B.C.

R. W. Brock.

For the pages containing Mr. Brock's report, *See* Index (Brock).

EXPLORATIONS IN THE ROCKY MOUNTAINS.

D. B. Dowling.

The work of the past season was directed mainly to obtaining more details of the coal areas north of the Saskatchewan and to an examination of the Athabaska valley. The explorations of the previous summer define in a general way the coal areas in the mountains between the main line of the Canadian Pacific railway and the Saskatchewan river. The route this spring lay outside this area, and some additional information was thus gained. The Foothill country which was traversed was found to have few exposures of rock; enough, however, were noted to show that in many places the tilted rocks forming the Foothill ridges were not all of the Upper Cretaceous but that many belonged to the Belly River series. A few indications of coal were seen, but nothing that appeared of economic value. The difficulty of approach naturally tends to diminish the value of measures in this vicinity. The Foothills in this region are a series of very high ridges running with the general trend of the mountains and dissected by deep transverse valleys.

The problem of accessibility will be an important factor not only for the coal of the Foothills but also for those fields situated within the mountain ranges to the west. An outlet for those just south of the Saskatchewan may be found by a devious course via the valley of a small stream north of Sheep river, but the grade to reach the Saskatchewan valley may be high.

While passing from James river to the Clearwater, behind a very high ridge, rocks were noticed closely resembling those of the Kootanie. Should this resemblance prove real, there may be found on the canyon of the Clearwater better coals than the majority of the Foothill fuels.

The uplift of the Bighorn range appears to have reached its maximum but a short distance from the Saskatchewan to the Brazeau, but evidence of an extension to the south is seen in the higher Foothill ridges. Northward they are not so pronounced, and fortunately for the future fuel supply of the northern roads they are more easily approached.

The development of mines in this district will both extend settlement to another large fertile area west of the Saskatchewan and open up a large lumbering area.

As the Saskatchewan valley is approached it presents a pleasing contrast to the rough country farther south. From high spruce covered slopes we descend to poplar groves and rich grass-covered flats. The general report from Indian trappers and traders is that the only point north of the Bow river near the mountains where surface features show prairie conditions (modified by the addition of scattered forests), is in the Saskatchewan valley. The wide river flats within the mountains are a famous resort for the Indians with their horses and cattle and we found on our arrival there in the latter part of May that horses had wintered there better than near Morley. The snowfall is less within the mountains than to the east, but it is not likely that the outer part of the valley will prove much less valuable for ranching purposes than the part we saw.

COAL AREAS.

The outcrop of the Kootanie measures on the south bank of the Saskatchewan was again visited and in addition to the seams found last year another of workable dimensions was discovered. This had a thickness of seven feet six inches, and the coal has a slightly higher fuel ratio than the five foot six inch seam found a year ago, but cokes much better. The analysis of the smaller seam was published in the Summary for 1906 (p. 72). These two seams would, therefore, appear to furnish the smaller steam coal and the larger coking.

On the Bighorn river several seams were seen in the canyon below the falls, but were not visited. About half a mile above the fall three seams that are close together could be worked as two. The lower two, separated by soft shale, have altogether ten feet of coal that in the laboratory forms a firm coke. The fuel ratio is slightly higher than in the coal south of the valley and on that account should make a higher percentage of coke per ton.

On the south branch of the Brazeau, behind the Bighorn range where the big seam was found last year, the prediction that other seams would be found in the same measures was borne out very fully. Several small ones, below workable size, were found, but eight in addition to the big seam contain sufficient coal to be workable. What was taken last year as another outcrop of the big seam is now thought to be a smaller additional one of eight feet. A fine-looking seam at the top of the lower part of the measures had eleven feet nine inches of clean coal separated from a five foot seam below by three feet of rock.

The upper portion appears to have the best coal. It is higher in fixed carbon and lower in ash. This seam and a five foot ten inch seam about 500 feet below it are the hardest coals of the district and have generally about three parts fixed carbon to one of volatile combustible matter.

The other seven known seams have an average fuel ratio as above of 2·5 parts to 1·0, and the big seam of last year is the lowest of the lot, with a ratio of 2·30.

The workable seams as far as known have the following thicknesses and come in the following order, beginning at the top. The figures are for the amount of coal in each:—

Fourteen feet 5 inches, 8 feet, 11 feet 9 inches, 4 feet 10 inches, 3 feet 11 inches, 5 feet 10 inches, 5 feet 8 inches, 8 feet 5 inches, and 3 feet 6 inches, giving a total of 66 feet 4 inches.

As only about half of the measures were prospected, there may be here as much coal as in the measures south of the Saskatchewan in the extension of the Cascade basin, namely fifteen workable seams with ninety-five feet of coal.

The generally wet weather of the past summer was very unfavourable for travel in the muskegs of the foothills. In order to reach the Athabaska valley, therefore, we descended Rocky river and examined the exposures of coal on Prairie creek, just beyond the mountains. These measures are in the upper part of the Cretaceous and do not compare very favourably with those just described. The analyses are not completed, but so far show that this coal is of about the grade of the Edmonton coal. The Prairie Creek coal will, however, be of value should an industry such as the making of cement be started near the mountains on the Transcontinental railway.

STRUCTURE OF THE RANGES.

The general type for the ranges as far north as the Brazeau has been likened to a series of long narrow blocks tilted up to form ridges—an imbricated structure. Northward this is modified in that the blocks are wider, but have suffered a great amount of folding. This lateral displacement becomes apparently greater toward the north, and many fine folds are to be seen in the Athabaska valley.

The edges of the blocks are pushed up to form the mountain chains, and do not show as many folds as are to be seen in the exposures lower down the westward slopes in the valleys. This has important results in that this folding has broken and pushed up the Cretaceous remnants, which contain coal in the mountains farther south, so that they have been carried away in the formation of the valleys. The highest rocks of this series that could be found were remnants of the black shales that lie below the Kootanie coal measures.

A notable example of this is to be seen in the first mountain at the gap of the Athabaska, called Folding mountain on McEvoy's map of the Yellowhead route. This hill is an anticline of Carboniferous rocks with a mantle of Triassic and Jurassic rocks covering its southern extension. A fault running parallel to the range just outside brings these beds against the Middle Cretaceous, and another fault to the west discloses them over-ridden by Lower Carboniferous, so that in the immediate vicinity of the river there seems no hope of finding the true coal measures. Northward the conditions may change enough to allow of some of the higher beds being found still in place.

COAL MINES.

After the field work was closed visits were made to several of the mines, and the following notes showing their progress may be of interest.

BANKHEAD MINE is producing about 1,000 tons per day, 500 of which is sized for market and 300 is compressed into briquettes. Another unit of the briquetting plant will soon be installed, and the total output will then be utilized.

At CANMORE the spur to the Sedlock prospect was nearly finished and the additional mine will soon be in operation. In the Canmore mine the main haulage way at the second level is being thoroughly re-timbered and widened to make room for compressed air haulage. A tunnel has been put through to No. 6, and the Cary seams, and mining on these will soon commence. The output should increase and is much needed for the railway.

At LILLE, to which a short visit was paid, it was found that the output was reduced to 400 tons a day on account of a fault which cuts the main seam at a slight angle. The coal is all washed and coked, making about 240 tons of coke.

BELLEVIEW is turning out about 700 tons, but an increase is expected shortly, when the management expects to handle 1,000 tons per day.

COLEMAN is mining from two of their best seams, one a coking coal and the other steam. The output is about 2,000 tons per day and most of the steam coal is shipped to the roads north of the Canadian Pacific railway.

THE CASCADES, PALLISER AND COSTIGAN COAL BASINS.

G. S. Malloch.

The season of 1907 was spent in completing the survey of a portion of the Rocky Mountains Park of Canada comprising the four most easterly ranges of these mountains and extending from Panther creek to the Clearwater river. This survey was begun in 1904 by Mr. D. B. Dowling and continued last year by the writer while acting as his assistant. Mr. Dowling has already mapped a part of the Costigan coal basin which occupies the first longitudinal valley, compiling his map from the survey made in 1904 and publishing it in the Summary report for that year. He also used the first year's work for the northern part of the Panther River sheet recently published in connexion with his report on the Cascade coal basin, but the southern portion of this sheet was taken from the Palliser and Sawback sheets of the Park survey made by the Topographical Surveys Branch. While these sheets extend westward across the mountains from the second range, Mr. Dowling's sheet begins in the middle of the second valley. It is therefore necessary that the complete map of the district now contemplated should republish Mr. Dowling's work and join the Topographical Survey's sheets on the south. On the northeast and southwest the crest lines of the first and fourth ranges formed natural boundaries for the survey which was primarily intended to define the areas of coal-bearing strata that occur in the longitudinal valleys between these ranges. On the north the survey was terminated at the deep transverse valley occupied by the Clearwater river.

PHOTO-TOPOGRAPHIC SURVEY.

In all three years' work the photo-topographic method was used for filling in the details of topography. Last year, as has been stated, our attention was devoted chiefly to the western part of the district and a large portion of the area covered was plotted on an approximate scale during the winter. It was found, however, that some additional photographs were required before the contour lines over parts of this area could be properly controlled. These were secured this summer and the eastern portion of the sheet was surveyed. In all seventy-one stations were occupied and thirty dozen photographs were taken.

TOPOGRAPHIC FEATURES.

A general idea of the district may be obtained from the statement that it consists of four mountain ranges separated by longitudinal valleys, and crossed by three main transverse valleys which have been eroded to a depth of 4,000 feet below the ranges and 2,000 below the general elevation of the longitudinal valleys. The four ranges are in reality the upturned edges of four fault blocks shoved up by pressure from the southwest. Since erosion has removed some 7,200 feet of strata from their backs and has left them still 2,000 feet above the longitudinal valleys, an idea of the magnitude of these faults may be obtained.

As a consequence of their mode of formation, the ranges have comparatively gentle slopes on the southwest, and are usually precipitous to the northeast, where their original characteristic as fault scarps has not been greatly altered by the erosion which has affected them since their uplift. In general the dip of the strata becomes greater from east to west across the district. This naturally increases the slope on the backs of the ranges, but decreases the width of the intervening valleys. Towards the south-east corner of the sheet, however, the dip of the strata of the first range increases and the width of the first valley decreases until it practically disappears altogether.

The transverse valleys, occupied by the three main rivers and certain of their tributaries that break through single ranges of the mountains before joining them, are characteristically flat-bottomed, and the side walls are precipitous where they cross the strong limestone strata composing the ranges. Even where they traverse the weaker shales and sandstones exposed along the edges of the longitudinal valleys, the side slopes are remarkably steep, and the tributaries draining the longitudinal valleys have gradients of at least 5½ per cent where they enter the transverse valleys. The gradient of the latter, on the other hand, is in some cases as low as 1 per cent, and does not exceed 2 per cent. Hence it is evident that all railways built to the coal fields must come up the transverse valleys.

GENERAL GEOLOGY.

The rocks of the district are all of sedimentary origin consisting of sandstones and shales above, and of massive limestones with a single thin shale band in the lower part of the series. Their ages range between Lower Cretaceous and Devonian, but the exact geological horizon to which some of the intermediate formations should be referred is as yet uncertain. Mr. Dowling* estimates the total thickness of the exposed strata in the vicinity of Banff at 16,000 feet, and there is no doubt that this estimate applies closely to our district. Of this enormous section the greater part may be seen repeated three times by any one travelling across the ranges. This is due to the fault block structure already referred to. These faults often bring the lowest members of the limestone series into direct superposition upon the higher beds of the sandstone and shales. Had the beds been undisturbed previous to the faulting the horizons of the different beds now brought into juxtaposition would depend solely upon the throws of the faults, and might be estimated from the relative elevations of the different ranges. There is plenty of evidence, however, that the beds were traversed previously by a number of folds whose axes were not parallel with one another or with strike of the fault planes since developed among them. These planes usually dip at low angles and truncate the anticlinal portions of these old folds. The broken strata have apparently been pushed out before the oncoming limestone and eroded away. Consequently, the same fault block overrides within short distances strata of very different horizons.

The series of sandstones and shales offers much less resistance to erosion than do the limestones, and have been entirely removed from the tops of the ranges, though some of the lower members extend part of the way up their western slopes. A marine formation known as the Fernie Shale occurs in the middle of the series, and owing to its weakness the depressions in the longitudinal valleys follow its outcrop. The sandstones of the coal measures above this formation are much less easily eroded, and often serve to protect the seams at considerable elevations above the valley bottoms. In the transverse valleys many of the weaker formations are buried beneath glacial drift.

* See his report on the Cascade Coal Basin,

NORTHERN EXTENSION OF THE CASCADE COAL BASIN.

Mr. Dowling's report* describes the occurrences of coal-bearing strata in this basin from the Kananaskis river to a point some six miles north of Panther creek. Beyond this the formation extends continuously to Rabbit creek, a distance of some thirty miles, but the strip loses its value as a coal field before that point is reached. To the south, this strip is interrupted near Panther creek, where a ridge in the centre of the valley is cut off exposing the heavy sandstone at the base of the measures which is here folded into a flat syncline. This fold also appears south of the Panther, where its axis is preserved by the basal sandstone that outcrops at the tops of some hills, but which is here folded more sharply. To the north this syncline flattens out still more and approaches the fault line, finally disappearing under the limestone of the fourth range midway between Panther creek and the Red Deer. From this point northward to the Clearwater the formation dips with some regularity to the south-west and passes beneath the limestone, there being a general parallelism between the strata and the plane of the fault. In spite of this fact, the upper part of the formation (where instead of the heavy sandstones of the lower there are thin-bedded sandstones and black shales), has been considerably crumpled by the weight of the superincumbent limestone, and numerous small thrust faults occur where the crests of the folds have broken, allowing the arms to slide past one another. The strata are also cut into a large number of transverse ridges by a succession of glacial cirques formed under the overhanging limestone cliffs which have also been eroded by the ice. The distance between the outcrop of the basal sandstone and the fault line varies in different parts of the strip with variations in the topography and the angle of dip, but three-quarters of a mile is about the average. It is also quite possible that some of the lower seams may be mined for some distance vertically under the limestone, for they are roofed in some cases by from twenty to fifty feet of strong sandstones.

As stated in the Summary report for last year,‡ a section of the coal bearing strata was measured in a favourable locality between the Red Deer and Clearwater rivers. From the basal sandstone a careful examination was made of the first 1,420 feet of the measures till the further continuity of the section was rendered doubtful by a number of crumples and small thrust faults. In all 114 feet of coal were found occurring in twenty-four seams, of which fifteen were between four and a half and eleven feet in thickness. Analyses, by Mr. F. G. Wait, of samples taken from seams 3, 5 and 10 gave the following results:—

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
No. 3	1·55	18·75	71·20	8·50
No. 5	2·05	20·75	73·12	4·08
No. 10	1·20	19·61	74·17	5·02

Of these the sample from seam 10, which is eleven feet in thickness, yielded a firm coherent coke. A sample also from one of the lower seams, which was collected by Mr. Dowling near the divide between the Panther and Red Deer,† gave the following excellent analysis:—

* Report on the Cascade Coal Basin, Alberta, by D. B. Dowling, B.A.Sc., 1907.
‡ See Summary Report for 1906, page 71.
† See Mr. Dowling's Report on the Cascado Coal Basin, page 35.

Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
0·72	21·28	75·80	2·20

This seam is five feet in thickness, and yielded a firm, compact and coherent coke. Three other samples, also from this basin, but representing seams near the top of the series, have been analysed. The first was collected, in 1886, by Dr. Dawson,‡ and the other two by our party this year. The results were as follows:—

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
No. 1	2·9	29·26	62·95	4·89
No. 2	2·14	23·83	69·67	4·37
No. 3	1·58	25·08	68·60	4·74

These three samples all yielded firm cokes. Along the banks of the Red Deer the coal-bearing strata outcrop for a distance of over half a mile, and their presence in the valley of the Clearwater is also certain, though they are concealed here by deposits of glacial drift. The coal in the hills immediately to the north and south of these valleys could, therefore, be mined very cheaply from tunnels driven along the strike of the seams at the level of the valley bottoms.

PALLISER BASIN.

This basin comprises the second longitudinal valley, and derives its name from the Palliser range, by which designation the third range from Lake Minnewanka to Panther creek is known. The width of this basin is greatest in the vicinity of Panther creek, and near it the only areas of coal-bearing strata are found. While these are five in number, only two are of economic importance, and even these are comparatively small, especially one to the north of the river. Moreover, even the basal beds of the series outcrop at an elevation of 1,000 feet above the valley, so that the construction of an expensive tramway to reach the tunnel mouths would be necessary. While neither of these areas presented sections of sufficient thickness to make them worth measuring, six seams are known in the northern and a two, and a five foot seam were measured in the southern. Samples* from these two seams gave the following results on analysis:—

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
2 ft	1·13	11·59	84·94	2·34
5 ft	0·93	10·58	83·55	4·94

These analyses indicate a first class steam coal very similar to that at Canmore.

COSTIGAN BASIN.

In the Summary Report for 1904 Mr. Dowling described† this basin in the vicinity of Panther creek, and in last year's Summary Report* the continuation of the coal-

‡Annual Report, Geol. Surv., Can., Vol. I. (N.S.), p. 146 B

* See Mr. Dowling's Report on the Cascade Coal Basin, pp. 34 and 35.

† pp. 116-121.

* p. 71.

bearing strata in two areas north of the Red Deer is noted. The area on the Panther, which we shall refer to as the Costigan area, is much the most important of the three, and extends from the south branch of Panther creek to the valley of the Red Deer. On the south branch the measures are folded in a syncline whose axis pitches sharply to the north. West of this syncline an anticline occurs before the fault line of the second range is reached, but the axis of this anticline converges with the fault line, so that it is not only absent on the main stream, but the lowest coal-bearing strata on the western limb of the syncline have been overridden by the limestone. On the eastern limb the whole series, and the lowest beds of the succeeding Dakota formation, outcrop. About this point, however, the pitch of the syncline flattens, and finally changes from the north to the south, so elevating the beds that the basal sandstone is cut off by the valley of the Red Deer. Along this valley the dip is low, and the beds are undisturbed except near the fault.

North of the Red Deer, and between two of its tributaries, the coal-bearing strata occupy another extensive area, but at an elevation of from one to two thousand feet above the valley bottoms. This we will call the Big Head area, from the name of the more easterly of the two tributaries. The dip throughout this area is very regular and at a low angle, but only the lower beds of the series occur.

The third area in this basin is bounded on the south by Scalp creek, the other tributary of the Red Deer, and takes its name from it. On the west it is bounded by the fault line of the second range as far as the Clearwater, where it terminates. To the northeast its outline is irregular, which is due partly to the erosion it has undergone, and partly to a succession of folds which disturb the measures. The beds are generally at a considerable elevation above the valley bottoms, but an exception occurs in the transverse valley occupied by a large tributary of the Clearwater, where a sandstone bed is exposed on the stream itself.

While no place could be found where a complete section across the measures was exposed, it was hoped that two sections at different points might be correlated. We were unable, however, to effect this correlation owing to the great similarity between the successive beds of sandstone and shale that compose the series, and to the variations in the thickness of the same bed within short distances. There also seem to be remarkable variations both in the number and in the thickness of the coal seams at different points.

The first section was situated at the southeast corner of the Scalp Creek area, where the measures are exposed on the face of a steep hill. From the basal sandstone 1,110 feet of strata were examined, but only six seams of coal were found, with an aggregate thickness of 12·4 feet. Of these the first and fourth might be worked, as their thickness is 3·8 and 3·3 feet, respectively. A sample from the second of these gave the following analysis:—

Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
1·90	16·10	76·89	5·11

No seams were measured in the Big Head area, but coal was seen in several places.

On the northern face of the Costigan area five seams were found of the following thicknesses: 1·1; ·5; 4·2; 1·9; 5·4; 3·8 and 2·3 feet. All these seams occurred in the first 400 feet of the measures, but no other seams of any value were found above them.

Samples from the 4·2 and 5·4 feet seams gave the following analyses:—

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
4·2 ft.	1·80	13·11	81·01	4·08
5·4 ft.	2 14	15·01	79·73	3·12

On Panther creek a section was measured from the top of the series across the western limb of the syncline until the beds became too badly crumpled near the fault line. This section was not complete as the beds were concealed in places by drift. In 1,350 feet of strata measured, only 910 feet were actually examined. In these, twenty coal seams were found, but as all those in the upper part of the section were mere ribbons of from ·2 to 1 foot in thickness, the aggregate was only twenty-six feet. Near the bottom of the section, however, four seams occur whose thicknesses are 3·8; 4·3; 5·4 and 3·8 feet, respectively, beginning with the lowest. Analyses of the first three are copied from the Summary Report for 1904,* while that of the fourth was made by Mr. F. G. Wait from a sample brought in by our party this year. They are as follows:—

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
3·8 ft.	·61	16·49	79·56	3·34
4·3 ft.	·79	15.66	76·05	7·50
5·4 ft.	·69	15·75	77·15	6·41
3·8 ft.	1·14	16·27	78·61	3·98

Of these the first and third yielded firm coherent cokes.

Two samples have been analysed from the eastern limb of the syncline where a four-foot seam outcrops. They gave the following results:—‡

——	Moisture.	Volatile Combustible Matter.	Fixed Carbon.	Ash.
No. 1	1·52	11 65	81·16	5·67
No. 2	1·14	13·63	80·64	4·59

These samples did not coke.

The occurrence of so many thin seams in the Costigan basin as compared with an approximately equal number of much thicker seams in the Cascade basin would seem to indicate that the edge of the original basin in which the coal-producing swamps occurred was situated not far to the east of what is now the first range. But, for the relative hardness of the coal in the first and second valleys to that in the third, and for the softness of this in comparison with that in the same valley at Bankhead, only thirty-five miles to the south, we can offer no explanation.

‡ p. 120.

* See Summary Report, 1904, pp. 119-120.

PASQUIA HILLS AND LOWER CARROT RIVER REGION.

W. McInnes.

In accordance with instructions, my work for the past season consisted of a geological and, to a certain extent, topographical, exploration of the country south of the Saskatchewan river and north of the Canadian Northern railway's Prince Albert branch, with more especial reference to the tract of high land known as the Pasquia hills.

Owing to the very late spring it was found on arriving at Winnipeg that the most expeditious method of reaching the ground was by way of Prince Albert and the Saskatchewan river. The Hudson's Bay Company's steamer was accordingly taken down the Saskatchewan river as far as the outflow of the Sipanok channel, a winding stream sixty miles in length, flowing from the Saskatchewan to the Carrot river and affording, excepting at extreme low water, a good canoe route between the two rivers.

At the Saskatchewan end the land on both sides of this channel is low, though the immediate banks, built up by the sediments dropped by the flood waters of the river, rise about fifteen feet above low water level.

No hard rocks were exposed *in situ* along the route, and the land behind the above-mentioned shore ridges was found to be too low to afford much soil fit for cultivation. Areas of good white spruce occur along the stream, principally on the banks, but often extending for considerable distances inland. Very tall, clean-stemmed aspen and balsam poplar of large size are mixed with the spruces, together with smaller elm, ash, oak and ash-leaved maple.

Proceeding down stream towards the Carrot river, the banks gradually become lower until, at the confluence of the two, they are but a few feet above low water.

On both sides of the Carrot river, above the inflow of the Sipanok, large areas of hay marsh occur that become lakes at high water.

Just above where the 14th-base line crosses the river a salt spring occurs on the left bank about twenty yards back from the stream. The pool is about six feet in diameter and is fringed with a border of the little red salt plant *Salicornea herbacea* and the salt-loving *Triglochin maritimum.* The water in the spring is slightly milky in appearance, strongly saline to the taste, and gives off a very noticeable odour of sulphuretted hydrogen. A sample was submitted to Mr. F. G. Wait, the Chemist of the Survey, for examination. He says:—

'As received, the water, about one quart, contained a trifling quantity of pale-brownish-white, flocculent, organic matter in suspension, which was removable by filtration. The filtered water was clear, bright and colourless. To the taste it was strongly saline. It was devoid of any distinctive odour, and reacted neutral, both before and after concentration.

'Its specific gravity at 15·5° C. was found to be 1,024; pure water being 1,000.

'The total dissolved saline matter, dried at 180° C., in 1,000 parts by weight of the filtered water amounted to 28·14 parts; equivalent to 2017·07 grains per imperial gallon.

'A qualitative examination showed the presence of:—

Potassa	very small quantity.
Soda	large quantity.
Ferrous oxide	trace.
Lime	small quantity.
Magnesia	small quantity.
Sulphuric anhydride	rather small quantity.
Carbonic anhydride	small quantity.
Chlorine	large quantity.
Silica	very small quantity.
Organic matter	not detected.

'Boiling produced a small precipitate consisting, principally, of calcium carbonate, with a little magnesium carbonate, and a trace of ferrous carbonate.

'The quantity of water available was too limited to admit of search being made for the presence of bromide, iodine, baryta or strontia, or boric acid.

'The principal saline constituent of the water is sodium chloride. A proximate determination of the chlorine showed that 100 parts by weight of the water contains 15·465 parts of that element; which quantity is equivalent to 25·48 parts of sodium chloride. Portions of the chlorine may, not improbably, be combined with the calcium or magnesium, but this can only be definitely determined by a complete quantitative examination. For this there was not sufficient water available in the sample submitted to me.'

Like the brines of Lake Winnipegosis and the adjoining districts, this spring with little doubt derives its sodium chloride from the leaching out of salt crystals from the underlying Upper Silurian rocks. It is a little lower in salt content than many of the springs to the south, but higher than some.

The Indians of the district have for very many years resorted to this spring for a supply of salt, though they could not, probably, have got a dry residue by evaporation.

The same low land continues up stream, gradually rising, however, in reference to the water level, until at the Pas Mountain Indian reserve the banks are seven feet or more above low water, and on the left bank the Indians cultivate fairly large fields of potatoes. A herd of eighty head of cattle is the property of the Indians here, together with a number of horses.

We bought on July 4 from the Indians a bag of last year's potatoes that were of good size and quality and in excellent condition, and on September 13 a bag of new potatoes equally good.

Above the Indian reserve the banks gradually rise, reaching heights of thirty feet before the rapids are reached, with groves of tall aspen poplar, balsam poplar, and occasional white spruce.

At the rapids, four miles above the west line of the Indian reserve, the stream has cut its way through a ridge of boulder-clay down to the bed rock, which here consists of ledges, exposed for five feet above the water level, of a very rotten, soft, quartzose sandstone in heavy beds, deeply stained with iron oxide and with pyritous nodules. No fossils were observed, but the sandstone contains some carbonaceous material in the form, apparently, of comminuted vegetable matter. A hard, purplish quartzose sandstone, strongly ripple-marked on certain beds, probably overlies the softer beds, as it occurs in large, angular blocks falling down from the bank over these strata.

The sandstone, in certain layers, becomes a fine conglomerate with pebbles of gneiss and other rocks and shows false bedding quite clearly in places. The strata, though apparently horizontal, must cross the river in a low anticline, as both above and below the boulder-clay comes down to the water level.

Overlying the hard rocks are forty feet of boulder-clay with striated boulders of sandstone, limestone and Archæan rocks of various types.

Owing to their isolated position and the absence of fossils there are few data for fixing the geological horizon of these sandstones. They probably, however, represent a part of the Dakota sandstone division of the Lower Cretaceous, described by Mr. J. B. Tyrrell in Part E. of the Geological Survey Report for 1890-91, from several localities in the Porcupine Hills area lying to the southeast of the region under consideration The ridge of boulder-clay underlaid by sandstones, that forms this long series of rapids on the Carrot river, is seen to extend westerly toward the Saskatchewan and is said by the Indians to be continuous to the latter river and to cross it in the vicinity of Birch island between the Nipawin and Squaw rapids.

The rapids, following the meandering course of the river, have a total length of eleven miles and flow through high banks of boulder-clay for the lower five miles.

This boulder-clay gives place, half way up the rapids, to rearranged glacier material, and, three miles from the head, to recent alluvial deposits that rise only five to ten feet above the ordinary level of the river and are flooded at periods of high water, when the sediment-charged waters on their recession cover everything with a film of fine silt. High banks of lacustrine stratified clay, rising from twenty to fifty feet above the river level, follow; a few miles farther on or from unsurveyed township 51, range 8, west of the 2nd meridian, to the surveyed townships, land of very excellent quality is found on both banks. This extends back from the river in the form of a slightly rolling plateau fifty to seventy feet above the river with a rather sparse growth of small poplars. The subsoil is the stratified clay spoken of above, a lacustrine deposit that is overlain by a deep, black, loamy soil. In parts, this country might be classed with the mixed prairie and wooded lands and everywhere the open growth of small poplars makes the section one very easily brought under cultivation. The river, along this part of its course, is not more than about twenty-five miles from the Canadian Northern railway.

The only exposures of hard rock *in situ* occur about forty miles above the Red-earth Indian reserve, where fissile, soft grey shales, containing enough bituminous matter to constitute a bituminous shale, are exposed in cliffs about fifteen feet high. These shales dip to the southwest at a low angle. The remains of fishes, and other fossils contained in them, and their close resemblance to the Pas Mountain beds, (to be referred to later) show them to be referable to the Niobrara division of the Cretaceous.

West of range 13, where the townships have been subdivided, occasional homesteads are met with, occupied, for the most part by Norwegians who appear to make good settlers and who successfully raise grain and mixed crops.

The very unfavourable weather during the early spring months of this year delayed farming operations in the district considerably, but nothwithstanding these unfavourable conditions the farmers interviewed were sanguine as to their grain crops, a large proportion of which they hoped to save. Some would be cut green for profitable use as green feed for cattle, of which the settlers generally carry a good stock. Large areas of wild hay occur all along and much of this is cut and stacked for winter use.

Though the land along this part of the river is generally of very good quality, the section lying below the surveyed townships, referred to above, seems to be of even more desirable character as it is higher above the river and has generally a heavier clay soil. Of the surveyed and subdivided lands, the area occupied by the Indians as Indian reserve 100 R. is particularly attractive. Little agricultural work is done on the reserve where it borders the river, beyond securing a fairly large quantity of the wild hay.

The most easterly ends of the Pasquia hills are situated, approximately, in N. lat. 55° 34′ and N. long. 102°. Rising on this side, first by a gentle slope from the low land and then quite sharply, they reach an elevation of, probably, 2100 feet above sea level, the height of the lowland being between 800 and 900 feet. The high land extends southwesterly gradually decreasing in height above the sea to a little over 1,600 feet and, owing to the increase in the general level of the land, becoming an elevated tract with more gradual slopes, so much so that the Prince Albert branch of the Canadian Northern railway crosses it without difficulty and by quite moderate gradients.

All about their base is a wide, flat area of hay marsh, swamp and lake extending northerly, northeasterly and easterly to the low hills beyond the Saskatchewan river. From the top of these hills, this broad, flat plain is seen to be dotted with lakes of all sizes from large bodies of water down to mere ponds. They are all shallow and without definite shore lines, merging gradually into the surrounding hay marshes. Trees and bushes occur only in groves and belts throughout the plain. From three to five miles from the edge of the lower slope of the hills a belt of marshy grass land that seems to be persistent is characterized by salt springs and brackish water and a vegetation that includes a true salt water flora.

The possibility of draining this vast plain, now too low to be of value, is a subject that deserves serious consideration, as practically all the land on both sides of the Saskatchewan, down as far as the mouth of the river, is of the same character and aggregates many thousand square miles in extent. If, as has been suggested, clearing out or excavating a drainage canal at the Grand rapid near the mouth of the river, where there is a descent of 100 feet or more in about four miles, would accomplish the purpose, the undertaking would be well worth while, but many factors must be taken into consideration; in particular, it should be ascertained to what extent the river bed is of easily disintegrated materials, and to what extent floored by the flat dolomites that would be resistant.

The enormous amount of sediment still carried down by the river and its tributaries from the south would also have to be reckoned with. Parts of the low plain near the base of the hills are being raised by the deposit of this sediment, but in general it is found that only a belt a few yards wide along the immediate banks of the rivers is being built up, the low land behind being covered nearly always in time of flood by clear water whose outlets are dammed back by the swollen river. The muddy water of the river meets this local, clear water a very short distance back from the banks, and in this practically always wooded belt the slackening current allows the water to drop part of its load of sediment, thus gradually forming an elevated ridge along each bank. the low. flat land behind receiving little or no deposition from the flood waters.

The only exposures of rock in place met with on the mountain were found in gulches eroded by streams flowing down the hill-slopes. They consist for the most part of soft, grey, fissile shales that contain a considerable amount of bituminous matter, enough to cause them to burn freely with the emission of a strong odour of petroleum when heated in the camp fire. The best exposures were found in the valley of the Nabei river where a section in ascending order, as nearly as it could be made out, gave:—

Thirty-five to forty feet of thick-bedded, soft, grey bituminous shale or thin-bedded sandstone, holding the remains of fishes which seem to be *Enchodus shumardi,* large bivalves probably *Inoceramus problematicus*, and *Foraminifera.* Though the first named species range widely in the Cretaceous of northern Manitoba they occur most freely perhaps in the Niobrara.

Six inches of harder, compact, impure limestone filled with fine shells that are probably *Ostrea congeste.*

One hundred and twenty feet or more of soft, fissile, light-grey (almost black when wet) bituminous shales holding the comminuted remains of fishes and many species of *Foraminfera.* Dr. Whiteaves, after preliminary examination, states that these fossils are clearly Cretaceous and very probably Niobara. Mr. Wait found that these shales on ignition leave 70·17 per cent ash. From this the hydro-carbon content can be approximately inferred, as one-half or more of the remaining percentage would consist of hygroscopic and combined water. When heated to redness in the camp fire the hydro-carbons were volatilized and burned with a bluish flame giving off a strong odour of petroleum.

Fifteen feet of clay iron-stone beds in layers six inches to a foot in thickness with shaly partings. A sample of the clay iron-stone was submitted to Mr. Wait for examination. He says of it:—

G.S.L., No. 469, 1907.

'The sample of clay iron-stone from Pas mountain, Saskatchewan, has been found upon analysis, conducted by Mr. M. F. Connor, to contain :

Metallic iron	29·10	per cent.
Insoluble mineral matter	9·20	"

Ten feet, soft, fissile, grey shale, probably quite similar to the thick beds below.

A varying thickness of boulder clay, the boulders chiefly of limestone but occasionally of Archæan gneiss.'

Near the eastern end of the hills the bituminous shales were again found in the brook valleys. Their occurrence here and in the valley of the Carrot river, as noted on a previous page, shows that they underlie the whole extent of the hill country.

The Pasquia river for forty miles or more above its mouth flows through low land with extensive hay marshes and shallow lakes. At a distance of about thirty miles from the mouth, just about at the eastern boundary of Saskatchewan, it forks with two branches, the northerly branch approaching close to the Carrot river at the second meridian, and heading in small streams coming down from the hills, and the southerly branch taking a great sweep to the south, crossing the new branch of the Canadian Northern railway at two points, and heading also in the hills. To a point some distance above the forks the stream is deep and smooth, with low banks. On the main or south branch above this point rapids are numerous where the stream flows through boulder clay which forms banks here and there twenty-five feet high.

Some good spruce and poplar occur along the river but there is little land suitable for settlement. Both branches, after leaving the hills, flow through a great hay marsh and swamp where their channels are often indefinite and not navigable even by canoes. There are two Indian reserves on the lower Carrot river, both situated near the northeastern end of the Pasquia hills, one at Red-earth lake and the other at Shoal lake. Both bands, as they are cut off entirely, owing to their isolated position, from other employments, are hunting Indians who depend largely on their catch of furs for subsistence. Both, however, raise enough potatoes to supply their immediate needs and to carry over the winter for use in the following spring and summer. They even exported a small quantity from Shoal lake to the Pas village. A few horses are kept on each reserve and small herds of cattle. At Red-earth there was a herd of upwards of eighty cattle, the property of the Indians themselves, who appear to take considerable pride in them and who keep them in good condition. The band at this reserve, everything considered, appear to be more comfortable and contented than any other band of Indians with whom I have come in contact in the northern country.

Of large game the moose is by far the most plentiful. They range during the summer months in great numbers over the flat land between the hills and the Saskatchewan river, retiring to yard during the winter in the higher land and on the slopes of the mountain. The smaller red deer is fairly plentiful along the upper parts of the Carrot river where the land is fairly high. Black bears are fairly numerous, and the ordinary fur-bearing animals of this latitude are not uncommon. A large colony of beavers was observed at work on the Carrot river. They had built a good sized house and were starting work on a dam across the river. Several species of ducks and a few Canada geese breed in the district and both are found in very large numbers at the time of their autumn migration, when they form the staple food of the Indians.

The fish of the region are neither very good nor very plentiful owing largely, probably, to the absence of deep lakes and clear-water rivers. Sturgeon, whitefish and doré are caught, however, and pike and suckers are plentiful.

Good white spruce grows in a belt of varying width along the Sipanok channel and down the Carrot river. Mixed with the spruce are poplars, aspen and balsam, which grow to be large trees with tall, clear trunks. On the flanks of the hills aspen and spruce of merchantable size are found. The best trees, however, occur on the mountain side 500 feet or thereabouts above the plain. Here are tall, smooth-trunked spruce of large size with occasional large white birch, elm and aspen. On the upper Carrot, above the long rapid, areas of very excellent spruce occur and between the two branches of the Pasquia is an area that promises to yield a good quantity.

Since my summary report of last year was submitted Dr. Whiteaves has more definitely determined the set of fossils brought in from Cormorant lake and its vicinity. This later determination confirms the conjecture, then hazarded, that all these dolomites are of Cambro-Silurian and about Trenton age. The northern boundary of the Silurian is thus brought somewhat farther south than was before supposed to be its position, nearly down to the Saskatchewan, in fact.

The great plain of the lower Saskatchewan and Carrot rivers is, therefore, probably immediately underlain by Silurian, and the lower slopes of the mountain, where all exposures are concealed, by whatever thickness of Devonian may intervene between the top of the Silurian and the Lower Cretaceous beds exposed at the rapids on the Carrot river.

Surveys by Rochon micrometer telescope and surveyor's compass were made of the Sipanok channel, Carrot river from the long rapid to the mouth and Pasquia river from the forks to the mouth. Track surveys were made of the upper branches of the Pasquia river, of the Carrot river from the long rapid to township 48, 13° west of the second meridian and of tributary streams flowing from the Pasquia hills into the Carrot and Pasquia rivers.

Mr. Chester P. Brown, of Paris, Ont., a student at Toronto University, acted as my assistant during the summer and gave entire satisfaction.

EXPLORATIONS ALONG THE NATIONAL TRANSCONTINENTAL RAILWAY LOCATION FROM STURGEON RIVER WESTWARD.

W. H. Collins.

The field season of 1906 was devoted to explorations of a twenty-mile belt flanking the proposed course of the National Transcontinental railway between Lake Nipigon and Dog lake. This year work of the same nature was continued westward as far as Clay lake, some forty-five miles northeast of Kenora. The combined seasons' reconnaissance covers a tract 216 miles long and about twenty-five miles wide, traversed medially by the railway location.

On the way to the field the writer was enabled, through the courtesy of the Director and Professor Leith of the University of Wisconsin, to join the biennial geological excursion to the Lake Superior iron ranges, organized by the Geological Department at Madison. This year the party consisted of about twenty members from Wisconsin and northwestern universities under the direction of Professor Leith and Dr. Grant. The Penokee Gogebic, Vermilion and Mesabi ranges were visited and some conception of the ore deposits and methods of handling was gained, besides a visual examination of the geological environments of each range. In view of the advanced nature of the mining operations and the detailed geological knowledge which has been accumulated concerning the origin of these enormous ore bodies, the visit proved of especial value for purposes of comparison during the subsequent field work in Ontario.

The entire party to be engaged in field work during the summer, six in all, assembled at Osaguan on May 29, and set out for Sturgeon lake, which was reached on June 7, after considerable delay owing to the persistence of the ice, vestiges of which remained until the middle of the month. Work was commenced on Savanne lake on the 11th, and progressed steadily until Sept. 20. A party of four was engaged continuously surveying the waterways of the country while the writer attended to the geological exploration.

GENERAL TOPOGRAPHY.

The area covered this year, like that of last season, is a peneplain of crystalline rocks thinly and unevenly soil covered and, for the most part, forested with evergreens. Rounded, rocky-summited hills up to 200 feet high, disposed in confusing irregularity, are the dominant topographical feature. Well defined valleys and continuous ridges hardly exist. The lower levels are soil covered. Thick deposits of soil are unusual and of local extent, being either till or stratified materials laid down in their valleys by streams.

The entire area drains northward and westward into English river, the principal tributaries being the Sturgeon and Wabigoon. On account of the prevalent flatness of the region, none except the smaller brooks flow rapidly. Rapids and waterfalls are infrequent. Indeed, so trifling is the slope, the smaller southern tributaries of Lac Seul (an expansion of English river) flow up stream with perceptible current when, during periods of prevalent westerly winds, the level of the lake has been slightly raised by retardation of its flow. Sturgeon and English rivers are, at most points in their course, lake-like rather than river-like in appearance, having widths of from one-half to four or five miles, irregular rocky shores and no visible currents except at occasional constrictions in their channels where rapids or cascades obtain. The paucity of soil, slight gradient and the resistant character of the rocky floor, are directly responsible for these peculiarities. Wabigoon river, however, and all its feeders, traverse a broad clay-filled valley, in which favourable material they have developed true fluviatile characters,—parallel banks, uniform gradient and consequent infrequency of rapids and falls.

Lakes, due to the same features that give Sturgeon and English rivers their peculiarities, are remarkably numerous and often of large size. Lac Seul is about eighty miles long, Minnitaki thirty. Any part of the region is accessible by canoe and certain chains of lakes, since the commencement of railway construction, are traversed by lines of small steamers and gasoline launches.

GEOLOGY.

The rocks of this area fall easily and naturally into two groups: (1) an older series of fine-grained eruptives and sediments of Keewatin and probably also Lower Huronian age; (2) a later intrusive series of pale-coloured granites and gneissoid modifications of the Laurentian period. The latter occupy much the greater area, forming, when geologically mapped, the ground colour upon which appear two elongated patches of schists.

The more easterly of these patches extends as a narrowed tongue from the main body around Savanne lake southwestward along the Dog river ,pointing out about eight miles above its mouth. The band is about five miles wide at its base and tapers gradually. The second schist body is widely elliptical in form, enclosing Lake Minnitaki; its major axis extends about fifty miles in a southwesterly direction from just south of Dog lake to Gull lake. Its northern edge lies from one to five miles south of the N. T. C. Railway location, crossing it, however, at Lost lake; the southern boundary is defined upon Geological Map Sheet No. 5 of this Department.

All the members, both igneous and sedimentary, of these areas dip perpendicularly or at high angles and extend northeast and southwest in the direction of the major axes. The igneous members are porphyries, porphyrites and diabases more or less altered to schists. They are identical with the original Keewatin group. Associated with them is a series of sediments, also metamorphosed, whose most conspicuous member is a conglomerate of granite, quartz and fine-grained eruptive pebbles enclosed in a matrix varying in texture from a grit to glossy chlorite schist. This conglomerate passes, by the thinning out of its pebbles and by gradations in the texture of its matrix, into slates accompanied by banded quartzite and iron ore bands. The group presents analogies with the Lower Huronian elsewhere in Ontario. At the time of Laurentian intrusion both eruptives and sediments were given highly tilted altitudes which, along with the acompanying metamorphis, has obliterated their planes of contact and rendered distinction difficult. The presence in the conglomerate of greenstone pebbles suggests a time gap between it and the Keewatin.

The Laurentian, at first sight an unintelligible complex of granite, gneiss, diorite and pegmatite, must be considered as the product of differential plutonic intrusion of a granite magma into the older Keewatin and Huronian rocks. As now exposed it consists of biotite-gneiss and granite grading from one to the other ,and containing, particularly in the gneisses, masses of diorite-like inclusions and basic, hornblende-bearing schlieren, the whole being cut by dikes and bosses of pegmatite. A comparison of various specimens of the pegmatite and granite does not disclose much difference in texture or composition between the coarser granite specimens and the finer pegmatites. Rather ,they form a graded series marked by: (1) an increasing coarseness of texture, accompanied by (2) a corresponding increase in silica and alkalies.

The schists at their contact with the gneisses have been altered to a crystalline hornblende schist and within the adjacent Laurentian are angular blocks of the same material. Observation of their inclusions at various points, and the basic, drawn-out schlieren, admits of their correlation by a second graded series of forms varying in definition of outline and basicity. Practically every rock type observed in the Laurentian formation this season may be referred to either the granite-pegmatite igneous group or to the hornblende-bearing inclusions. Under deep-seated conditions, a magma, initially of the composition of biotite granite but towards its final stages growing richer in alkalies and silica, slowly intruding an older formation like that of the schists, might be expected to produce a complex similar to that above described.

MINERAL DEPOSITS.

Iron.

Attention was directed last* year to the existence of magnetite west of Savanne lake. Since that time a number of prospectors have visited the range and staked some twenty claims. To gain more definite information a second visit of about two weeks' duration was made in June of this year ,and surveys, to provide for the compilation of a hand map of the locality, were undertaken. The country is thickly forested and a covering of moss and soil conceals the rocks. For this reason geological examination was restricted to the lake shores where exposures are almost continuous. In some places the iron formation where concealed was detected by the use of a dip needle.

The northern boundary of the schists is only a short distance north of Kashaweogama lake, extending thence northeasterly to Savanne and westerly to the south end of Cliff lake. They continue for about three miles south of Kashaweogama and Island lakes. A wedge of Laurentian enters between Cliff lake and the south shore of Island lake, all running westward to Kashaweogama. All the schists dip steeply and strike at from 200° to 240° except in the strip reaching to Cliff lake. An igneous and a sedimentary series occur, but relationships and their actual boundaries are obscured by their highly altered condition. Chlorite and sericite schists are the principal forms seen on Houghton lake and the south side of Island lake. Most of these are probably altered eruptives; however, both types are met in the sedimentary series at points where faulting or shearing has taken place. The development of chlorite and sericite schists from sedimentary material is observable in the conglomerate matrix which varies within narrow limits from a distinctly clastic grit to smooth schistose rock substance. This dual development of chlorite and sericite during the folding and compression of the

* Summary Rep. G. S. C., 1906, p. 106.

Keewatin and Huronian has helped to obscure any original plane of separation between true sediments and true eruptives. Greenstones of rather massive character appear on Pickerel lake. On Cliff lake, Kashaweogama and eastward to Savanne true sediments predominate. A band of conglomerate about 100 feet wide extends from Island lake along Kashaweogama for two-thirds of its length, appearing farther east on Iron lake. A broader conglomerate body lies just east of the Savanne narrows. On both sides of the first mentioned band are dark-coloured siliceous slates which grade insensibly into the conglomerate matrix. These slates contain the iron formation, consisting of alternate bands of quartzite (jaspilite) and siliceous magnetite, slate and chlorite schist. The magnetite bands, ranging from less than an inch to several feet in width, extend indefinitely in the direction of rock strike.

The iron formation exists on both sides of Kashaweogama lake on the portage between Island and Cliff lakes; it outcrops over a width of about 1,000 feet. Eastward the country is swampy and the rock formation hidden. At a mile north of the east end of Kashaweogama magnetite bands were detected by the dip needle beneath a covering of sand. The formation appears again near the north end of Iron lake, on the portage to Savanne lake and at numerous points just above Savanne narrows. At all these points the seams of ore are narrow and siliceous and of no value.

The south side of Kashaweogama is better mineralized. The belt is at least a quarter of a mile in width and contains bands of ore from seven to sixteen feet wide. These extend from a point midway along Kashaweogama to within a short distance of Grebe lake. An average specimen selected from a sixteen foot band was analysed by Mr. F. G. Wait of this Department and reported on as follows:—"Sample of iron ore from a point situated about ten miles west of Savanne lake consists of an intimate association of magnetite, with some hematite and a larger proportion of siliceous—mainly quartzose—gangue. It has been submitted to analysis and found to contain:—

Metallic iron	30.74%
Insoluble siliceous residue	55.70%
Titanic acid	None.

Analysis of another specimen, obtained from the laboratory of the Atikokan Iron Mining Company yielded 53½% of metallic iron.

The geological surroundings are quite comparable with those of the Vermilion range of Minnesota. Iron oxide exists within the slates in considerable amount, but as yet no favourably situated dikes have been found. However, the surface is so hidden by forest growth that their absence cannot be inferred. Dikes cross-cutting or forming a wall of impervious pitching troughs must be sought for in the exploration for ore. The existence of hematite in association with the magnetite is favourable, but unlike the jaspilite of Timagami and Vermilion ranges, the Kashaweogama quartzites are in dull grey and black tones, red bands being infrequent. The claim owners are in expectation of seeing a diamond drill at work next season.

In the schist area enclosing Lake Minnitaki magnetite bands also occur under geological conditions identical with those at Kashaweogama. At Sioux Lookout, just below the junction of the English and Sturgeon rivers, the vertically oriented slates contain iron ore bands, which, however, are narrow and commercially valueless. Iron ore in small quantity has been found near Hidden lake on the north side of Sturgeon river. The interval between the two points has been investigated, but as the direction is that of the general rock strike the mineralization may be continuous.

GOLD.

While en route to Savanne lake a brief visit was made to the Sturgeon Lake gold mining district. Work had been suspended at the St. Anthony Reef mine at the end of March but was expected to be resumed with the opening of navigation upon Sturgeon lake. At the close of working the 100 foot level continued to show abundance of mineralized quartz and schist yielding average values of $10.67 per ton, about 60% of which was free milling, the remainder in the pyrite concentrates which formed about 7% to weight crushed. Some prospecting to the east of Couture lake had revealed a vein carrying free gold, pyrite, chalcopyrite and a little native copper. In Belmore bay the Douglas Mining Company and Messrs. Fawcett and Bourion had, during the winter, erected excellent camp buildings in expectation of beginning mining with the coming of spring.

Small quartz veins carrying free gold are reported from the schists of Dog river just north of the second lake expansion, by Mr. Estrom, a prospector. Free gold in small amounts is also reported from about Minnitaki and English river.

At a point about five miles S.S.W. of the Hudson's Bay Company's factory on Lac Seul, the writer in examining the beach sand obtained a single small colour of gold. The sand consists of quartz, garnet, magnetite and greenstone grains, some of which no doubt are disintegrated Keewatin material; a small amount of gold may have been obtained from the same source. Sands of this character are very abundant on Lac Seul.

PYRITE.

The Keewatin rocks everywhere contain a considerable amount of pyrite in disseminated crystals and small concentrations. Quartz veins in that formation are usually pyritiferous. A large body of pyrite on the northeast of Vermilion lake, whose existence has been known for a number of years, is now being exploited by the Northern Light Mining Company, representing New York capital. A clearing of about twelve acres has been made, camp buildings have been erected and a wagon road three miles long has been cut to Vermilion river from where a gasoline boat connects with Minnitaki. Forty men were at work. Development thus far has been exploratory and no atttempt has been made to mine and ship the ore. A vertical 6 x 8-foot shaft, 103 feet deep, has been sunk so as to intersect the ore body and at 86 feet drifting in a north and south direction was being advanced in July. One drill and the shaft hoist are operated by steam power. The ore body fills a fissure extending from beneath the lake in a northeasterly direction. The rock on either side is a somewhat sheared diabase. The ore is a fine-grained pyrite containing some silica and a little chalcopyrite. At the 86-foot level a southerly drift of about 20 feet shows solid ore and no sign of the wall.

An outcrop of pyrite associated with magnetite was noticed on the English river just south of Pelican lake. It is only a few feet wide and, from surface appearance, of no value.

FELDSPAR AND MUSCOVITE.

Pegmatite dikes and bosses are a characteristic feature of the Laurentian formation. These are composed of acid, alkali-rich coarse textured rocks probably representing the ultimate stage of Laurentian intrusion. Quartz, feldspar, mica and magnetite are the ordinary constituents. Usually the pegmatite bodies are only a few inches or feet across. However, just south of Gull lake, is a more extensive mass in which the crystallization is coarser than usual. Feldspar occurs up to eighteen inches in diameter and mica in sheets sometimes six inches across, the latter frequently occurring in two zones parallelling the streaks of quartz which run for short distances. The muscovite quarries of the United States are situated in pegmatite veins and coarse granites similar in general character to the rocks at Gull lake, although often the home of rare minerals not as yet seen in the Canadian occurrences. Those of the Black hills in Dakota most closely resemble the Ontario forms, the mica being one constituent of a coarse granite. The muscovite 'books' at the surface of the Gull Lake granite are weathered and have lost much of their resiliency, but beneath the surface a better quality no doubt exists. The sheets obtained at the surface could be trimmed to two by two inches and three by three inches, scarcely larger, none being seen exceeding six inches across.

SOILS, ETC.

All the inorganic soils distributed over the region are of glacial detritus. In many places the original deposits from melting glaciers are preserved much as originally laid down. Boulder clay is scattered locally over the whole area, but the heavier, continuous deposits lie to the south of Lac Seul between lats. 92° 15′ and 92° 45′. High banks of sand are exposed along the shores of Lac Seul. Railway grading west of Lost lake has exposed splendid transverse sections of sand ridges laid down by streams at the edge of glaciers, the sand possessing a convex bedding. Much of the country south of Rock lake and around Gull lake is heavily covered with sandy or loamy till. Certain other soils have been laid down in well stratified beds. As far as Clay lake the Wabigoon and its tributaries occupy a valley filled with bedded clays, forming an area about thirty-five miles in length and from five to ten miles wide. These clays are horizontally beddded in thin gray or red laminae. For agricultural purposes the Wabigoon clay is excessively tough and impervious to moisture, tending to bake firmly in dry season and flood during wet weather. A considerable farming community exists around Dryden and a few settlers live along the Wabigoon as far as Minnitaki station. Hay grows in some luxuriance along the shores. The till deposits above mentioned are nowhere under cultivation. An exceptionaly large proportion of arable land is comprised within the limits of Indian Reserve No. 28.

The timber seen this year is of much finer quality than that between Lake Nipigon and Sturgeon lake. Both white and red pine are common from Dog lake westward, but are confined to small areas, usually forming clumps and groves on sand ridges. A large grove of both varieties seen at the north side of Pine lake contained individuals three feet in diameter. Red pine, eighteen inches in diameter, was commonly met south and west of Lac Seul. Banksian pine is abundant and of a size suitable for making railway ties, forming the chief source of tie timber for National Transcontinental Railway construction purposes. Spruce is prevalent everywhere, tamarack much less so. At fifteen miles above the mouth of Dog river is some excellent tamarack, specimens measuring from ten to twenty-four inches in diameter. Poplar and birch are the chief deciduous trees, specimens of the former on Gull river reaching thirty inches in thickness; yellow birch eighteen inches in diameter was measured on Dog river. Elms and an occasional oak grow in the Wabigoon valley. Timber growth, where deep soil exists, is rapid and trees grow to a large size. Unfortunately much of the country has been devastated by fire. Practically no live timber remains in the Wabigoon valley and, recently, fires have run over the country between Sturgeon river and Lake Minnitaki.

Water power is available on Wabigoon river at the National Transcontinental Railway crossing where a fall of twenty-five feet occurs. Also at Pelican falls on the English river, the descent being about thirteen feet. Both these are within very short distances of the railway line. Smaller powers are available at the mouth of Dog river and the head of Pelican brook.

Access to the country has been greatly facilitated since the advent of railway construction. A line of small steamers and a nine mile stage line connect Abram chute with Dinorwic. A wagon road eighteen miles in length runs north from Dryden to the National Transcontinental Railway location and another road, nine miles long, connects Wabigoon falls with Vermilion bay.

SHORE LINES BETWEEN GEORGIAN BAY AND THE OTTAWA RIVER.

A. F. Hunter.

On May 20 I began the work of tracing the 1,040 feet shore line in the country east of Georgian bay, and completed the investigation in July. In ordinary circumstances the broad water plain of this shore line makes it an easy one to follow, regardless of whether the margin is well defined or not. But the irregular, rocky surface of the Laurentian areas throughout the district which it was necessary to traverse, introduced practical difficulties of no light kind.

On the interlake peninsula surveyed in 1905 I had found this compound shore line to include three strands at about 1,080, 1,040 and 1,000 feet, respectively; and as already mentioned in the report of that territory, I had adopted the middle one to define the whole group. From the examination of this new territory, I obtained no results differing from those of the interlake peninsula, except that of greater denudation on the Laurentian. The harder rocks of the latter are much less drift-covered than the Silurian rocks of the former, and, accordingly, the covering of drift over the Laurentian is very scanty in most places.

The foregoing remarks apply only to the main mass enclosed by the 1,040 feet shore line on the Laurentian. This mass is roughly quadrilateral in shape, with an elongation toward the southeast, and another toward the west, in accord with the two systems of rock foldings, commonly found throughout the district.

On the other hand, the 1,040 feet shore line through southern Ontario encloses islands of thick drift deposits. These I had traced and examined in the fall of 1906, with the exception of Durham county.

During August, 1907, I made the circuit of the 1,430 feet shore line in the central parts of the high tract under review, viz., between Georgian bay and the Ottawa river. The map and report prepared and submitted herewith give the main features of this shore line so far as it was practicable to investigate them.

The examination of the three shore lines thus completed brought out the fact that they approach each other on the northeast quarter more closely than elsewhere. There is much bolder relief of the land along this face, and here there has been much greater erosion of the steeper declivities.

A unique alteration takes place in the shapes of the land areas enclosed by the three shore lines respectively. The lower, or 790 foot area, is elongated in a northeast and southwest direction. The 1,040 foot area is quadrilateral; and the 1,430 foot area, or oldest of the three, has its longer axis from the northwest to southwest in agreement with the strike of the Laurentian.

PETERBOROUGH AND SIMCOE SHEETS.

W. A. Johnston.

During the past season the mapping of the Simcoe sheet was continued according to instructions.

On May 27 I proceeded to Kirkfield, Ont., where I was joined by J. H. Stothers, of Ottawa, Jas. Hill, M.A., of Stratford, Ont., and Bert R. McKay, of Cornwall, Ont., who acted as my assistants throughout the season's work, which lasted until Oct. 4.

In July and August, while the mapping of the Simcoe sheet was being carried on by my assistants, some four weeks were spent by me in making necessary surveys in connexion with the mapping of the Peterborough sheet, in obtaining a series of photographs of that district and in an examination of the outcrops of Utica shales and Trenton limestones, along the shore of Lake Ontario eastward from Whitby, with a view to defining the contact of the two formations, and including in the Peterborough map sheet the strip of country along Lake Ontario from Whitby to Trenton.

Exposures of Utica shales occur at Whitby, Oshawa and Bowmanville, but over most of the area a heavy mantle of drift obscures the surfaces of the rock. In a bore-hole at Whitby the Utica shales were found to have a thickness of seventy feet. At Oshawa and Bowmanville they merely form a capping a few feet thick over the Trenton limestone. The beds dip towards the north and occupy a basin-shaped area the exact limits of which could not be determined on account of the great accumulations of drift.

The Simcoe sheet lies adjacent to and west of the Peterborough sheet and embraces an area of forty-eight by seventy-two miles, the central portion of which is occupied by Lake Simcoe. In undertaking the mapping of the Simcoe sheet it was thought advisable to introduce contouring, in order that as complete and accurate a topographical map as possible might be produced. To this end instrumental levels were taken over all the roads in the area mapped during the summer, which included the greater portion of the sheet lying east of Lake Simcoe, and the work was plotted and the contouring and topography done in the field, thus ensuring greater accuracy than would otherwise be possible. In this work bicycles were used as a means of traversing the roads and by their use we were enabled to accomplish more than would be possible either on foot or with horse and rig.

Very little work had previously been done, by officers of the Survey, in this portion of Ontario, and the mapping of the eastern part of the Simcoe sheet has resulted in the acquisition of much knowledge concerning the distribution and occurrence of the Trenton, Black River and Birdseye limestones, which underlie most of the area, and of the Archæan rocks occupying the greater part of the townships of Digby and Dalton in the northeastern corner of the sheet.

The Head river, which forms the south branch of the Black river, flows for some distance, after issuing from Head lake, along the contact of the limestones with the granite and gneisses. At Uphill and Dartmoor two outliers of limestone have been formed by the river cutting a deep channel through the main body of the limestone, at a time probably when that rock extended much farther over the Archæan areas to the north. The lower end of Mud lake is occupied by Archæan rocks. The upper end occupies a shallow basin in the Black River and Birdseye limestone and drains north into the Head river. At Sebright the contact is again seen, the limestones forming a bold escarpment which strikes in a northwesterly direction towards Lake St. John in Rama township.

Along this northern border of the limestone series numerous sections are exposed of the limestones and shales underlying the Trenton formation. In a section measured just west of Head lake there was found to be at the base twenty feet of red and green shales with occasional thin beds of coarse sandstone or grit, resting on two or three feet of rotten granite. Scattered through the shales are numerous crystals of marcasite and small rounded pebbles of quartz, but no fossil remains could be found, with the exception of *Scolithus*-like markings in the arkose at the base, which fossil, however, is of little value for the determining of horizons. The shales are calcareo-argillaceous in character, soft and friable, readily weathering where exposed, and forming the rich red soil characteristic of the areas near the contact of the limestone series with the underlying Archæan rocks. The red and green shales pass upward into fine-grained, evenly-bedded, greenish-grey and dove-coloured limestones having a total thickness of fifty feet. The greenish-grey beds are somewhat arenaceous and are generally devoid of fossils. The upper twenty feet of this portion of the section is composed of dove-coloured stone, lithographic in physical character. These beds are characterized by a great abundance of a species of *Leperditia*, a *Bathyurus* and numerous small tube-like forms filled with calcite, and beds of the same character and containing the same fossils are interbedded with the greenish-grey arenaceous beds towards the base of the section. The whole section is capped by ten feet of massive dark-coloured beds containing an abundance of the characteristic fossils of the Black River formation such as *Columnaria halli*, *Stromatocerium rugosum*, &c. None of these fossils was found in the underlying beds and there is quite a distinct line separating the fine-grained *Leperditia* beds from the heavy dark beds of the Black River.

At Coboconk a good section is exposed of these massive dark-coloured beds, which are regarded as belonging to the Black River formation, showing the contact with the underlying fine-grained *Leperditia* beds and also the contact with the overlying Trenton. The Black River beds here have a total thickness of about twenty-two feet.

The Black River formation may be used as a datum plane in that it is continuous from the east to the west side of the Frontenac axis both in Ontario and in New York state.

On the east side of the Frontenac divide there is the regular succession down through the Black River, Chazy, Calciferous and Potsdam. On the west side of the divide in New York state, according to Prosser and Cumings* the Chazy is not at all, and the Calciferous only partially developed; and the next formation below the Black River is referred by them to the Birdseye (Lowville). This formation consists of compact dove-coloured limestone, apparently quite similar to the fine-grained *Leperditia* beds described in the above section. In the section near Trenton Falls, N.Y., as described by Prosser and Cumings, the Birdseye limestones become somewhat aren-

* Report of State Geologist, N.Y., 1895.

aceous towards the base, and pass downwards into calcareous sandstones, regarded by them as Calciferous in age.

Similar limestones occur in the Kingston district of Ontario, and regarding them Dr. Ells says in the Summary Report for 1901: 'In physical characters, the lower portion of the limestone formation north of Kingston resembles some of the limestones of the Chazy formation of the Ottawa district.' So far as known, however, no typical Chazy fossils have been found west of the Frontenac axis. It is possible that these fine-grained beds below the Black River formation are equivalent in time space to the upper part of the Chazy of the Ottawa district, yet in the absence of fossil evidence, which would serve to correlate these beds directly with the Chazy formation, it seems preferable to refer them to the Birdseye, as is done in New York state.

Throughout the Peterborough district these beds, which are regarded as belonging to the Birdseye formation, rarely exceed thirty feet in thickness and have, generally, at their base a few feet of calcareous grit or arkose derived from the immediately underlying crystalline rock. In some cases the Black River beds rest directly on the crystalline and have a similar arkose at their base. In a section exposed near Burleigh Falls at the base of the limestone series a six-inch bed of typical Birdseye limestone was found to be overlaid by two feet of calcareous grit, and at the Burnt River quarries the Birdseye limestones become interstratified with arenaceous beds towards the base of the series. Hence it would appear that over part of the area at least the grit and arkose beds are merely a local development at the base of the limestones.

In the Simcoe district the beds below the Black River have a thickness of over seventy feet, including twenty feet of red and green shales at the base, and whether the whole series should be referred to the Birdseye formation is not certain.

The Black River limestone, when free from chert, is chemically purer than either the Trenton or Birdseye, and is more extensively used in the manufacture of cement and lime. In the Simcoe district good exposures of the Black River beds occur in Carden township.

Occasionally large masses or seams of fossiliferous chert occur in these beds and, where accessible, would no doubt prove valuable for use as road metal. On lots 11 and 12 of concession 3 of Carden township, a seam of chert six to eight feet wide is exposed for a distance of ten chains.

AN AREA FROM LAKE TIMISKAMING EASTWARD.

Morley E. Wilson.

As the geological formations, which in Ontario have been found to contain silver-cobalt-nickel ores, were known to extend eastward into the province of Quebec, an examination of the area to the east of Lake Timiskaming was undertaken, during the summer of 1906, with a view to obtaining more detailed information in regard to the geology of the district. The area of Huronian and Keewatin rocks was found to be too extensive for their examination to be completed, the work of the season being confined to the townships of Guigues, Duhamel, Fabre and the surveyed portions of Baby and Laverlochere. The present field season was spent in the region immediately to the east of these townships, thus completing the surveys necessary for a geological map of an area extending along the east shore of Lake Timiskaming from the Quinze river to the south end of Fabre township, and eastward to Lake Kipawa and Lac des Quinze. A preliminary map of last year's field work has already been published; this, however, will be included in a final sheet of the whole area on the scale of one mile to the inch.

I was assisted during the past season by Messrs. Douglas Ells, Gerald Galt and W. L. Carr, all of whom rendered willing and efficient service in the accomplishment of the work.

PHYSIOGRAPHY.

The east shore of Lake Timiskaming from Lavallee bay to Apika creek presents a somewhat rugged appearance, due to a succession of quartzite ridges which rise abruptly to an elevation of from two to three hundred feet above the lake. From Apika creek to the Quinze river, and extending throughout Guigues and eastern Duhamel, a large clay area occurs. This comprises roughly the lower part of the basin of the Otter river. There are also smaller areas of clay or sand throughout southern Baby and northern Laverlochere. The southern portion of the sheet is characterized by numerous low, rocky hills whose rounded contours, denuded of vegetation by forest fires, form a marked physical feature of the region.

The lakes of the area are confined largely to northern Baby and the neighbourhood of Lake Kipawa. In the latter district they are exceedingly numerous and show in nearly every case a northeasterly or northerly parallelism in the trend of their basins. The lakes of the first class are shallow and correspond in direction to the strike of the gneiss in which they occur; those of the second class are deep and apparently have no relationship to either the strike of the rock or to the direction of glacial movement.

A few of the lakes in the southeast part of the sheet have their outlet into Lake Kipawa, but with this exception, the drainage is almost exclusively into Lake Timiskaming. In the more rocky districts the streams abound in rapids and waterfalls but elsewhere they meander through clay flats with little current, save where an occasional outcrop of rock obstructs their course.

GEOLOGICAL SUCCESSION.

The geological sequence on the Quebec side of Lake Timiskaming is very similar to that found in Ontario. The oldest series in the district, the Keewatin, consists of greenstone, green-schist, quartz-porphyrite and serpentine. Through this igneous complex a Pre-Huronian granite has been intruded. The latter and the Keewatin are overlain in places by the Huronian, the basal member of which is a conglomerate. This conglomerate grades up into greywacké, which in its turn changes gradually into arkose or quartzite. Quite frequently, however, the greywacké and conglomerate are entirely absent, the arkose resting directly upon the granite from which it is derived by decomposition *in situ*. The deposition of the Huronian was followed by an intrusion of the granite and gneiss and at a still later date by diabase, chiefly in the form of dikes. Niagara limestone, sandstone and conglomerate are found fringing the shore of Lake Timiskaming. Pleistocene clays and sands are also largely developed.

KEEWATIN.

The group of rocks comprising the Keewatin occurs in several localities. The largest area occupies the whole of the western part of Baby, extending from the Quinze river to the southern end of the township, where it comes in contact with the Pre-Huronian granite. Its eastern limit, as on the south, is marked out by the Laurentian, which occurs two miles east of Long lake. The western border of the area is buried in clay and hence cannot be sharply defined, but isolated exposures occur as far west as the seventh range of Guigues. The northern half of the area just outlined consists of uralitic diabase, diorite and hornblende-schist, while the southern portion is made up of quartz-porphyrite. Other localities in which the Keewatin occurs are north of Rousselet lake, east of Clear lake, the fifth and seventh range of Fabre and the seventh range of Duhamel. In the first two localities the rocks consist of greenstone, hornblende-schist and serpentine, in Fabre township of schist and porphyrite, and in Duhamel of serpentine.

The complex of igneous rocks comprising the Keewatin is thus largely of a metamorphic character. The less altered areas, which consist of uralitic diabase and diorite, change gradually into hornblende-schist and serpentine, the latter probably representing the extreme result of metamorphic action. The quartz-porphyrite, which is intrusive through the other members of the series and is therefore later in age, has not been subjected to such extreme alteration. It consists of phenocrysts of quartz, plagioclase and, less frequently, orthoclase, enclosed in a fine-grained, chloritic ground-mass.

HURONIAN.

Huronian conglomerate and greywacke occur widely throughout the territory in question, but usually either in small isolated outcrops or in bands of no great thickness at the base of quartzite ridges. The largest area is that found in southern Laverlochere extending from Otter lake to Rousselet lake and southward into Fabre township. The conglomerate consists of a matrix of varying texture enclosing well-rounded fragments of granite, green-schists, diabase, diorite, quartz-porphyrite and other rocks, that variety lying immediately beneath being much the more abundant. When sufficiently exposed the conglomerate is usually found to pass upward into greywacké by the gradual loss of its pebbles and boulders.

The upper member of the series, the equivalent of the rock which Professor Miller has called Lorraine arkose on the Ontario side of the lake, is confined to the succession of hills and ridges bordering the east shore of Lake Timiskaming. The rock is a coarse-textured quartzite passing through all the intermediate modifications to arkose, the latter being found in those portions resting directly on the Pre-Huronian granite. The quartzite occasionally passes upward into conglomerate by the addition of pebbles and boulders of granite and other rocks. The most typical example of this was observed at the eastern extremity of the road between ranges VI and VII, Fabre township. Pebbles of quartz and jasper occur locally throughout the quartzite. These areas are particularly abundant in the vicinity of Ville Marie. As a rule the quartzite, as well as the underlying conglomerate and greywacké, is but slightly disturbed, the dip rarely exceeding 20°. The transitionary character of the contact between the quartzite aand the underlying members of the series can be seen at three points on the shore of Lake Timiskaming, namely, on the south shore of Lavellee bay, on a point to the south of Joanne bay, and on the bay to the north of Wright's mine. It can also be observed on the slope of the ridge which parallels the 'Quinze' road across range V, Duhamel. No evidence of unconformity was observed in any of these localities.

GRANITE AND GNEISS.

Two distinct, acid, igneous rocks are found in the region: the first may be termed the Pre-Huronian granite, and the second the Post-Huronian granite and gneiss.

The Pre-Huronian granite (Laurentian), which cuts the Keewatin but antedates the Huronian, occupies the northern part of Laverlochere township and the adjoining portion of Duhamel. It also occurs on the shore of Lake Timiskaming at the south end of Fabre township, and on Baie des Pères.

The rock is a biotite granite, the biotite being present in very small quantities. It is usually very coarse and in the southern part of the Laverlochere area becomes a typical granite-porphyry. The relationship between the granite and the green schist of the Keewatin is well shown on lot 6, ranges IV and V, Laverlochere. At some points the contact is of a transitionary nature but at others it is quite definite, dikes of the granite penetrating the Keewatin. The contact between the quartz-porphyrite and the granite is not sufficiently exposed for their relative ages to be determined. The unconformity between the Huronian arkose and the Pre-Huronian granite is one of the striking geological features of the Quebec side of Lake Timiskaming. The arkose passes by an insensible gradation downward into the granite from which it is derived. Rock-sections from this contact, as found on the lake shore south of Ville Marie, have already been described* by Dr. Barlow. The same relationship on a larger scale was found exposed for a distance of nearly three miles in the northern part of range IV, Duhamel. There is a contact on the shore of Lake Timiskaming opposite Drunken island, in which the granite has been broken down in a similar manner, but the overlying rock is the basal conglomerate. On the other hand the junction between the basal conglomerate and the granite exposed on the lake shore, in lot 18, range I, Fabre, is very definite without any evidence of decomposition of the granite surface.

The Post-Huronian granite and gneiss comprise the whole of the southeastern part of the area mapped. It is probable that the gneiss and part, if not all, of the granite enclosing Lac des Quinze belongs here also, though in the absence of overlying Huronian the two granites cannot be separated. The distinction between the granite and gneiss is very indefinite, all intermediate types being found. The gneiss not only possesses a parallel arrangement of its constituent minerals but is also banded,

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*Annual report, G. S. C., vol. x, p. 100.

the alternate bands differing only in the amount of biotite or hornblende present. The biotite gneiss is much the more common. Occasionally the banding is replaced by an irregular arrangement of light and dark granite or gneissoid granite. Basic nuclear segregations frequently occur at these points. The strike of the gneiss approximates a northeasterly direction but local variations are very numerous. The contact between Post-Huronian granite and Huronian greywacké is exposed for a short distance about one mile southwest of Otter lake. The line of junction is very definite with small dikes or stringers cutting the greywacké along the margin of the granite. Elongated patches of conglomerate included within the gneiss were observed to the east of Otter lake. An area of a rather complex rock occurs in the township of Fabre, which possibly represents a marginal basic variation in the Post-Huronian granite and gneiss. The rock has been subjected to considerable dynamic action and is cut by fine-grained granitic dikes, which also cut the granite and gneiss. In the less altered portions it appears to be a coarse diorite. The absence of contacts with nearly all of the neighbouring rocks makes its correlation exceedingly difficult and, until thin sections of the rock have been examined, the writer cannot express a definite opinion as to its age.

DIABASE.

The Post-Huronian diabase which occurs in the region is chiefly in the form of dikes, the largest of these being that which extends in a northeasterly direction from Otter lake. There are a number of dikes cutting the gneiss in the vicinity of the outlet of Lac des Quinze. One of these extends across the lake as a chain of islands.

SILURIAN.

Remnants of the Silurian syncline which occupied the northern part of the Timiskaming area occur at numerous points along the east shore of Lake Timiskaming. From Chief island to Piché point a boulder conglomerate occasionally interrupted by quartzite fringes the lake shore. Small patches of an arenaceous limestone slightly inclined to the southwest occur at frequent intervals from Piché point to Faure bay. Detailed descriptions of these outliers have been previously given in various reports on the Niagara of Lake Timiskaming. A small hill of Niagara almost enclosed in drift was observed on lot 18, range II., Guigues. This is a calcareous sandstone dipping 5° to the southwest, without fossil remains.

PLEISTOCENE.

The Pleistocene of the region consists largely of clay with local surface areas of sand. The clay is distinctly stratified and in the vicinity of the Otter river forms well-marked terraces.

ECONOMIC GEOLOGY.

No discoveries of economic importance have as yet been made, though a considerable amount of prospecting has been done. Since the silver ores of Ontario are associated with the Post-Huronian diabase, the limited extent of this rock in the area examined greatly reduces the probability of similar discoveries being made. Two iron range areas are known in the Keewatin of the region, one in the neighbourhood of Clear lake and the second crossing the portage from Kakake lake to the Quinze river. In the Clear Lake area two parallel ranges appear on the surface at varying intervals. They consist of bands of quartz and siliceous magnetite carrying a large amount of iron pyrites. The maximum width of the outcrops is thirty feet. The Kakake iron range consists largely of jaspilite but, like the Clear Lake occurrences, is not of sufficient extent to be of value. Iron pyrites is a usual constituent of the Keewatin green schist and greenstone, and occasionally the mineral is found in small vein-like deposits, conforming to the strike of the schist. These frequently contain a small amount of chalcopyrite but the ore body is not large enough, nor the percentage of copper high enough, to justify mining operations. The diorite of Fabre township appears to be well mineralized, containing chalcopyrite, galena, calcite and other minerals. No large quantities, however, have been located.

REPORT ON THE DISTRICT ALONG THE NATIONAL TRANSCONTINENTAL RAILWAY FROM BELL RIVER EASTWARD.

W. J. Wilson.

The work of the past summer consisted in an examination of the country along the line of the National Transcontinental railway from Bell river eastward to the Susie river near the headwaters of the Gatineau river. A strip, varying in width from five to ten miles north and south of the line, was examined as carefully as time would permit. The principal exploration was done in canoes, following rivers and lakes near the railway line. But there are large areas through which there are no canoe routes and these were examined by traverses through the woods on foot. These traverses were made at intervals sufficiently near each other to give a good general knowledge of the geology and natural resources of the country. It should be clearly understood, however, that in surveying a country which is everywhere forest covered, without roads or other easy means of travelling between the rivers and lakes, it is impossible to examine every hill or rock exposure in detail. To do so would mean that only a comparatively small area could be finished in one summer. The weather the whole summer was unfavourable and much time was lost on account of rain, in which respect the season was exceptional.

Wabanoni lake, which lies west of Obaska lake, was first examined. It was surveyed by compass and micrometer, and a similar survey was made of Migiskan river from the last crossing of the railway line up to the north end of Millie lake, also the Atik, a branch of the Migiskan, including Atik, Couillard and Durant lakes. A track survey was made of the route between Durant lake and the Susie river. This route is through several small lakes and long portages and includes parts of the Kekek and Kapitachuan rivers.

Wabanoni lake is situated about two miles west of Obaska lake. It is surrounded by low shores wooded with spruce, poplar and canoe-birch. Rock exposures are seen along the south shore and the southern part of the east shore and are chiefly diabase. At the extreme south there is a rusty-quartzose rock holding considerable quantities of pyrite.

The southern part of Obaska lake included in the district examined, is bordered by low ground rising gently back and on the west side covered with a dense growth of small spruce and poplar. The rock as mapped by Dr. R. Bell is mostly green schists. These schists continue down the Bell river almost to the final location of the railway line ; north of this, granite and gneiss extend beyond the border of the district to be examined. The country along the south exploration line between the Bell river and the Migiskan is comparatively level, and is covered with a dense forest of spruce and poplar alternating with Banksian pine knolls and black spruce swamps. Near the Bell river, diabase containing numerous quartz veins was the only rock observed. Three miles west of the Migiskan diabase, hornblende-schist and granite were seen.

The Migiskan river rises near the sources of the St. Maurice and Kapitachuan rivers and is about 130 miles long. The last fifty miles of its course is through the area under consideration, where it is between 500 and 600 feet wide. The las twelve miles are almost a continuous rapid. Above that to Millie lake there are several rapids and short stretches of swift water. Some of the worst rapids had portages cut past them during the present summer. From the north the river receives several branches, of which Sunday creek, Crooked creek and Trout brook are the largest. At its most southerly bend where the railway cache is situated, it receives a stream of considerable size from the south, and six miles farther up the Atik enters from the east. The banks of the Migiskan are usually low, with an occasional hill in the distance. The soil close to the river is mostly alluvium, but in places there are considerable areas of sand. Trees of a good size grow on the richer ground along the river, especially spruce and poplar. In the adjacent country canoe-birch and Banksian pine are common. Opposite the Migiskan cache and less than a mile south of the river there are two large white pine trees (*Pinus strobus*). These were the only white pine seen on the river and seem to mark the present northern limit of the species.

At the first rapid and portage above the railway line the rock is a rather fine-grained reddish-grey granite with a somewhat gneissic structure. Following the river the next outcrop is seen nineteen miles farther up, or nearly two miles below the mouth of the Atik, where there are two small exposures of a dark hornblende-schist which are almost covered by water. There is, however, an outcrop of similar rock on either side of the stream flowing into the Migiskan opposite the railway cache. On the west side these rocks are well seen in a low hill about a mile and a half south of the Migiskan, and on the east side in a hill about three-quarters of a mile. In this hill the rock is a greenish schist containing small grains of calcite holding pyrite. There are at the same place quartz veins six inches thick but as far as examined they hold no mineral of economic importance. Above the mouth of the Atik on the Migiskan the next rock occurs a short distance below Trout creek and is a gneissoid-granite. The same rock is seen on the portage into Millie lake. This portage is through a recently burnt Banksian pine plain and is over a mile and a half long.

Millie lake is an expansion of the Migiskan river and is from a mile to a mile and a half wide for nine miles when it narrows to less than a quarter of a mile and continues narrow as far as it was surveyed,—about three miles. The shores are mostly hilly and at the northeast end present some perpendicular cliffs. All the rock observed on this lake was gneissoid-granite or gneiss and the same rock was seen eastward along the trail line up Smoky creek and on Cedar creek and adjacent hills.

Along the railway line between the crossings of the Migiskan river granite and gneiss are the common rock. Crooked creek, which enters the Migiskan a mile and a half below the railway cache, was ascended and was roughly surveyed. It is thirty to forty feet wide and has low banks mostly clay and sand covered. As the stream is ascended the country for some distance back becomes hilly with several isolated, rounded peaks, composed of gneissoid-granite much broken up. At the railway line there is a Banksian pine plain with large areas of muskeg to the west. Seven or eight miles north of the railway line up Crooked creek there are numerous dikes or masses of diabase through the granite and the country is hilly and broken. Some hills rise 500 feet or 600 feet above the railway line or 1,600 feet above sea level.

The Atik river was examined and surveyed to the north end of Durant lake, a distance of fifty-four miles. For the first twenty-three miles, or up to Hill portage the river forms a very good canoe-route, but above that there are numerous rapids up which the canoes had to be pulled by hand, or taken over a portage cut. Nearly all the rapids can be run with partly loaded canoes. The adjacent country is generally sandy and covered with Banksian pine. Large areas of the forest along this river were destroyed by fire in 1906. Well foliated gneiss is abundant and becomes garnetiferous at the Atik cache, forty-five miles from the mouth of the river, and continues increasingly so to the east as far as examined. In some of the hills it is metamorphosed and much altered.

Along the rivers, lakes and portages from Durant lake to the Susie river there is little change in the country, forest or rocks. Garnetiferous gneiss, well foliated and striking in a general way east and west is seen in frequent exposures, while sand plains covered with a small growth of Banksian pine prevail. There are, however, large areas well wooded with spruce, poplar and canoe-birch. Much of this country has also suffered greatly from recent fires.

The rocks observed in the western part of the district are green schist and diabase which seem to grade into each other without any sharp line of separation, they probably belong to the Keewatin. All the eastern part of the area is underlain by granite and gneiss with small dike-like masses of diabase. The granite and gneiss are Laurentian while the diabase is probably post-Laurentian.

There are some areas along the streams and also on the spruce and poplar slopes away from the streams which are fit for cultivation, but the district as a whole is not an agricultural country. The general level along the railway line is from 1,100 feet to 1,450 feet above sea level, with hills several hundred feet higher.

Mr. Arthur J. Merrill accompanied me as assistant and rendered me valuable aid.

I wish to acknowledge my indebtedness to the engineers, transport officers and cache keepers of the National Transcontinental railway who assisted me in every way possible.

EXPLORATIONS ALONG THE NATIONAL TRANSCONTINENTAL RAILWAY LOCATION FROM LA TUQUE WESTWARD.

O. O'Sullivan.

According to instructions, I left Ottawa on May 16, to explore the country along the location of the National Transcontinental railway from La Tuque on the St. Maurice river westward to meet Mr. Wilson's party coming eastward from Bell river. Mr. H. W. Wood was my assistant for the season. The railway line follows the St. Maurice river to Waymontachingue, a distance of 72 miles, and then continues in a northwesterly direction for a distance of 85 miles to the crossing of the west branch of the Gatineau river, which we followed down on our return trip. The country from La Tuque to Coocoocache, a distance of 39 miles by the location, is very rough and hilly with sand plains and swamps between the hills. There are two good water-powers in this stretch. The La Tuque falls and rapids can develop 50,000 horse-power. The other power is at the Iroquois falls on the Vermilion river, a branch of the St. Maurice which is crossed by the railway line at 18 miles from La Tuque. From Coocoocache to Waymontachingue, a distance of 35 miles, the gneiss and granite hills rise sharply from the river and are high and rolling.

Forest fires have done much damage, principally on the west side, but there are still some large areas of good spruce. The soil is generally sandy or swampy except in the valleys of the large streams entering the St. Maurice river; there we found a rich loamy soil. Several good water-powers can be had in this last stretch.

From Waymontachingue we ascended the Ribbon river, which flows into the Manuan river about two miles west of Waymontachingue. This river takes its source from Lake Kamistgamak, about 28 miles in a northwesterly direction from Waymontachingue. It is a small stream flowing through a valley of from half a mile to three miles wide, with sand plains covered with moss and scattered growth of jackpine.

Leaving Kamistgamak a portage was made into the waters of the Gatineau river. By following a small crooked creek for three miles we entered Lake Menjobagus which is the largest sheet of water in the vicinity, measuring about eight miles long by one mile wide on an average. The country to the south is high rolling and well wooded with black spruce, birch, poplar and balsam.

From Menjobagus we descended the waters flowing to the east branch of the Gatineau river to Jack-pine creek, a distance of sixteen miles ; then followed up the creek to its source twelve miles west, and made a portage into the St. Maurice waters again. From this point the country to the south is well wooded with black spruce. Some white pine were seen on the east branch of the Gatineau.

From the source of the Jack-pine a portage of about a half a mile in length brought us to the East Cache creek, then by following down this small stream we reached Ascalaneo lake which forms part of a system of waters having many large lakes drained by the St. Maurice river. From this lake half a day's travelling took us to the west branch of the Gatineau river.

The rocks throughout the whole country which we explored are gneisses, granites and schists. The gneisses strike east and west and the small areas of schists strike in the same direction, both rocks dipping at various angles. The gneisses, especially in the western part of the country explored, contain large numbers of small crystals of garnet.

No economic minerals were found except some iron sands which have been handed to the chemist of the Mines Branch for assay.

SURFACE GEOLOGY OF THE ST. LAWRENCE VALLEY.

R. Chalmers

The field work carried out by me during the season of 1907 was practically a continuation of that of former years in the St. Lawrence valley, in the region extending from the Notre Dame mountains on the south to the Laurentides on the north, and from eastern Ontario and Lake Champlain on the west to the Gulf of St. Lawrence. The work was also extended to the slopes bordering the valley, more particularly to those on the south side.

I left Ottawa on June 12, proceeding to Sherbrooke, which was made our headquarters for about two months. My assistants in the field were Messrs. E. G. McMahon and R. M. Chalmers, two college students, both of whom rendered me good service, and besides doing other work, levelled the heights of a large number of the marine shore lines from the lower St. Lawrence westward to the United States boundary and the province of Ontario.

In 1905-6-7 a series of observations was carried on by the writer in southeastern Quebec, and measurements were made of the altitudes of the shore lines referred to. These are described in a report published in 1898*. The results then at hand were, however, fragmentary, but at subsequent intervals other facts have been added. Before this season most of the altitudes had been measured with aneroid barometers only, and consequently were more or less inaccurate, but during the past summer my two assistants levelled, with spirit level and rod, the whole series from Rimouski westward to the International boundary near Lake Champlain. Very full and, it is hoped, accurate results have been thus obtained. Photographs of a number of these shore lines have also been taken.

The observations made thus far indicate an undulating or wavy line or lines in profile throughout the whole St. Lawrence valley from the Gaspé coast westward, with a general rise in the same direction. A series of three of these shore lines usually occurs, the lowest being the most perfect, the middle one tolerably continuous and ths uppermost broken and denuded, and in some places almost entirely obliterated. These three are generally found together above the margin of the marine plain, which may, perhaps, also be called a shore line. Ascending the slope from the margin of this plain we observe the first and second of the shore lines referred to in apparently a horizontal attitude wherever the physical conditions have been favourable for their formation. These are almost always in a good state of preservation and can be followed for miles. The third or highest is the one which we everywhere levelled, as it denoted the maximum height of the uplift, though the two lower ones have also been measured in order to ascertain their deformation from a horizontal attitude. Taken together the three, in all cases, show deformation, and as pointed out in the report cited, with an increasing uplift westward till we reach the central part of the Eastern Townships. The

*Report on the Surface Geology and Auriferous Deposits of Southern Quebec, Geol Surv. of Can., Vol. X (new series), 1898.

highest point they attain appears to be in Wolfe and Richmond counties. West of this they descend gradually and are much broken up before reaching the International boundary. No attempt has been made to trace them beyond Canadian territory; but Baron DeGeer, a Swedish geologist, when in America in 1891 measured the altitude of a shore line in the vicinity of St. Albans, Vt., and found it to be 658 feet above sea level.

A considerable amount of work was also done in tracing the shore lines on the north side of the St. Lawrence valley. Here they are much more irregular and broken than on the south side, so much so that in many places it is very difficult to trace them continuously or even to identify them. The lowest shore lines are, of course, best preserved, the upper ones show great deformations, and in many places are entirely worn away by denudation. This fact would seem to indicate greater oscillation than on the other side of the valley. A tolerably full series of altitudes has been obtained, however, from the Saguenay river westward to Ottawa. Owing to my assistants having to leave me in September, and to other causes, observations are not as complete on this side of the valley as on the other side.

The changes of level referred to in connexion with these shore lines must have taken place about the close of the Pleistocene period or during the movements of the land which raised the Leda clay and Saxicava sand beds above sea level. The deposits constituting the shore lines are chiefly sand and gravel, similar to those of the Saxicava sand beds, and are doubtless of the same age.

A report, map and profile of these shore lines is in course of preparation.

THE MARINE PLAIN OF THE ST. LAWRENCE VALLEY.

The plain of the St. Lawrence valley which exhibits everywhere a comparatively uniform surface, with low undulations and protruding crystalline hills, does not everywhere retain the same contours as its rocky floor beneath. Stripped of the covering of surface deposits, the inequalities would be found to be greatly accentuated and valleys and basins would appear where now these deposits have levelled them off to an apparently horizontal plain. There is, however, a gradual rise from the St. Lawrence river outwards towards the mountains on both sides of the valley, besides an increase in altitude as we proceed up river from east to west. Filled-in ancient river valleys which existed before the present ones were eroded are found in places, and some of the inequalities in the rock surface of the valley must have been produced before the glacial period, as boulder-clay occurs everywhere in the depression beneath Leda clay and Saxicava sand.

The limits of the marine area designated the St. Lawrence valley were traced on the map during the past season with greater accuracy than had hitherto been attempted, and the character and distribution of the marine beds were studied in detail. As the inequalities of the surface of the plain referred to likewise affect the borders and slopes on either side, to a greater or less extent, and these are consequently seldom regular or horizontal for long distances, the border of the plain is often interrupted or broken. Atmospheric denudation has also played an important part as regards the evolution of these topographic forms.

GLACIATION.

The glaciation of the region, though carefully studied in 1895-98, was further examined at a number of critical points, especially on the south side of the valley, and it was found that the published work in the report referred to is substantially correct. The southern and southeastern limits of the Eastern Townships and the Notre Dame mountains were carefully examined for evidences of glaciation, but no new data were obtained necessitating a change of view from the conclusions set forth in the published work. It was found that at only a few places did ice from the Laurentides cross the International boundary, and then only in the passes at altitudes not exceeding 1,600 to 1,800 feet.

Abundant traces of the movements of the earlier Appalachian or northward-flowing glaciers were observed. In the townships of Shefford, Brome, &c., however, well marked striæ affording evidence of a westward movement were noted. The ice which produced them was probably a part of the Appalachian system. The same westward courses were seen in several places north of the International boundary between Brome lake and Lake Champlain.

Wherever traces of Appalachian and Laurentian glaciers are found together the accompanying boulder-clay falls into a corresponding two-fold division; that produced by the former is always the underlying, and contains only boulder from local rocks. The overlying boulder-clay of the latter glacier on the other hand contains a considerable proportion of material derived from rocks belonging to the north side of the St. Lawrence, i.e., from the Laurentide hills, and is found overlapping the older beds as far south as the Notre Dame mountains, and is, in the western part, carried farther south through the gaps and passes of the hills along the boundary line.

THE SERPENTINE BELT OF THE EASTERN TOWNSHIPS.

John A. Dresser.

In the month of April, I received instructions from the Director of the Geological Survey to begin an examination of the serpentine and allied rocks in southern Quebec, with a special reference to their economic products—asbestus, chromic iron, copper, talc, antimony, &c. This work was begun on May 3. The serpentines and peridotites are known to extend with more or less continuity from the Vermont boundary line to Gaspé. But for purposes of a detailed examination it was found necessary to begin with the portion of this area that should afford the best facilities for a thorough investigation. Accordingly, after a preliminary reconnaissance of the southern part of the field, it seemed best to concentrate the first season's work in the mining district of Thetford Mines and Black Lake, where the deposits of asbestus and chromic iron could be best observed, and also where many of the rock structures which are essential to a complete investigation, are well known. Thus, between May 3 and August 2, my time was spent in an examination of the serpentine belt, between D'Israeli and East Broughton, an area of thirty miles in length, and from five to eight in breadth. In this time about eighty mines, prospects and mineral occurrences were examined, as well as the natural rock exposures of the whole area. During the months of June and July I had the assistance of Mr. Alex. Maclean, senior student in geology, Toronto University, and of Mr. R. Randall Rose, student in the Faculty of Applied Science, in the same institution. Both of these gentlemen proved throughout capable workers and careful observers, and were indefatigable in their efforts to make their work efficient. I must also acknowledge with thanks many courtesies received from the owners and managers of the various mines in the district.

GEOLOGY.

The rocks of the serpentine, or peridotite, belt in this district form an intricate complex. The oldest rocks are a series of slates that were at first mistaken for highly altered sediments, but careful study in the field and examination of several thin sections under the microscope show them to be altered volcanic rocks having the general composition of porphyrite. It is possible that there are altered sediments amongst them, but this has not yet been certainly established. Through these there has been intruded the serpentine-peridotite which contains the asbestus, chromic iron and talc of the district. Associated with the latter are the granites, whose relation to the serpentine in point of age, seems, in some places, to have been contemporaneous, while in others they are of later formation. Besides these rocks there are large bodies of diabase of yet later age. This rock is especially characterized by strings and nodules of epidote. It contains the pyrrhotite-chalcopyrite deposits of Garthby and Lake Clapham, in this district, as well as those of Bolton and Potton, farther to the south. This diabase cuts sediments of Trenton age at Mount Orford, and thus indicates a comparatively late period of intrusion. In crossing this igneous belt, four separate bands of breccia are found, the largest of which is a quarter of a mile in width. The matrix is a volcanic rock of medium basicity, either porphyrite or an acid diabase. It contains abundant fragments of all the other rocks of the district, and appears within the diabase or peridotite, or between diabase and Cambro-Silurian sediments.

All the rocks of the district have been much deformed by regional metamorphism, and hence have been intruded before the completion of the Appalachian uplift, or previous to Permo-Carboniferous time.

The principal part of the investigation of these rocks was applied to the ore deposits, which can only be treated in an extended report. In general it may be said that the chromite occurs largely as a primary segregation from the original magma, and was thus the first mineral of this rock series to be formed. The asbestus, on the other hand, has been the last or latest mineral to be formed. It seems to have resulted from the alteration of bands of peridotite, rich in olivine, in which the metamorphism has been farthest advanced. The peridotite mass has been reduced to serpentine with the exception of 5 to 10 per cent of pyroxene, but along joint planes and fracture crevices the alteration to serpentine has become complete, and in its final stage the asbestus has been deposited within these joint or fracture crevices. To describe these occurrences in detail, however, further investigation, and an extended report, are necessary.

SURVEYS IN SOUTHERN NEW BRUNSWICK.

Dr. R. W. Ells.

The changes made during the summer of 1906 in the geological position of the Perry sandstone formation, through the finding of Devonian plants in these beds on Kennebecasis island and elsewhere, by which they were transferred from the Lower Carboniferous to the underlying formation or system, necessitated a revision of the geological formations included in the Devonian and Lower Carboniferous, from Lepreau on the west, to the eastern shores of Westmorland county. During the past season this has been nearly completed, and such separation of the red conglomerates and shales of the lower part of the Perry and the grey fossiliferous sandstones and shales of the upper portion, from the limestone, gypsum and other sediments of the Lower Carboniferous has been made as closely as possible. These changes include a considerable portion of the province south of the Kennebecasis valley and the line of the Intercolonial railway between St. John and Sackville.

In addition some time was spent in more closely outlining the areas of Cambrian rocks to the east of St. John city.

Among other changes which have thus been made in the geology along the north side of the Bay of Fundy is the transference of considerable areas of shales, conglomerates and sandstone, extending from the vicinity of Black river to Melvin beach, about seven miles east of St. Martin. On the published map these were in part assigned to the horizon of the Millstone-grit, and in part to the Lower Carboniferous; while to the north and east of St. Martin the areas so coloured were found to belong in large part to the Triassic. Thus the conglomerates of McCoy head, east of Black river, were recognized as a part of the Perry conglomerates, beneath which in the direction of Gardiner creek they were underlaid by a series of red and grey shales and sandstones that are apparently continuous downward and should fill a gap which on the east side of St. John harbour appears to occur between the Perry outlier of that place and the underlying Mispeck formation. Some portions of the grey beds along this shore contain plant stems which will require careful study later. Most of these sediments are highly inclined, showing the presence of faults and folds. In this work I was assisted by Dr. G. F. Matthew, of St. John.

Thence, continuing the work eastward to St. Martin, similar rocks were observed at many places, both along the coast and inland, till the old rocks of the coastal range were met, the upper grey beds containing fossils similar to those found in the grey beds of Kennebecasis island, where they directly overlie the red Perry beds.

At St. Martin the Triassic formation was greatly extended. The soft red sandstones and pebble conglomerates of the shore were found to be overlaid by a series of reddish beds having a uniform northerly dip for nearly two miles. This dip is reversed to the south shortly before reaching the older mountain rocks. In places, the Triassic sometimes rests upon the grey beds of the Devonian, and the presence of a well defined syncline is recognized. Plant stems were occasionally seen, but no collections of these were made.

Farther east, on the shore of Albert county, as at Point Wolf, and at Owls head, east of Alma village, the rocks are in part red conglomerate of the Perry formation. They here form a syncline in which the grey plant-bearing beds are well seen, and upon these are small unconformable outcrops of generally reddish Lower Carboniferous sediments with which are associated areas of gypsum. In the grey portion of the Perry at this place is a great abundance of plant remains which should furnish excellent material for the collector. The Perry rocks as a rule are highly inclined, and in places contain fossil tree trunks.

At Cape Enragé the red and grey beds of the Perry are also well exposed. The grey beds abound in plant remains, and the strata are generally highly inclined, in places reaching the vertical. The underlying beds are mostly red marls which lie between the grey and the coarse red conglomerate of the Perry. The central part of this basin around Germantown lakes shows an unconformably overlying series of Lower Carboniferous conglomerate with marly shales, which in places hold small deposits of gypsum. The Devonian rocks occupy most of the area between the Pre-Cambrian hills to the north and the shores of the Bay of Fundy, and eastward they extend to Grindstone island and Mary point, where large quarries in grey and brown sandstone were at one time worked extensively. Most of the rocks in this area between the bay and the mountain range to the north, are somewhat sharply folded. East of Albert village the Devonian rocks continue along the flank of the Caledonia mountain to Shepody mountain, and it is possible that the conglomerate of the latter represents a large outlier of the Perry conglomerate, since in no part of the recognized Lower Carboniferous have any such masses of these conglomerates been observed. Along its southern flank also there are several outcrops of limestone and gypsum with red shales of the overlying formation.

Crossing the mouth of the Petitcodiac river to Cape Maringouin the red marls and grey sandstone of the Upper Devonian again appear with high dips, and are overlaid unconformably by deposits of gypsum at what is known as Pink ledge, on the west side of the peninsula. Similar beds appear farther north on the roads to Sackville and Dorchester, occasionally with nearly vertical dips. These are sometimes overlaid by grey sandstone of Millstone-grit age, and sometimes by sediments belonging to the Upper Carboniferous formation.

The series of bituminous sediments usually known as the 'Albert shales' extends through Albert and eastern Westmorland and is a portion of the Upper Devonian, resting in places on the red beds of the Perry, and affected by the same disturbance that is seen generally throughout the Upper Devonian of this area.

Along the valley of the Kennebecasis bay and river the Perry conglomerates and upper shales are continuous from Kennebecasis island past Hampton to beyond Sussex. South of this place, along the valley of Trout creek, as far as the mountains south of Waterford village, the hills of Dutch valley are for the most part made up of overlying Lower Carboniferous sandstone and conglomerate, beneath which occasional anticlines of the Devonian outcrop along the river valleys. In this area the Albert shales are seen at a number of points, and they have been traced almost continuously from a point a couple of miles north of Hampton village into Westmorland county, though occasionally concealed by the overlying Lower Carboniferous beds.

In addition to the areas thus described, several outliers which rest upon Pre-

Cambrian rocks and were formerly regarded as of Lower Carboniferous age were examined, and were also found to be of Perry age.

To the west of St. John city the geology of Pisarinco peninsula was revised. It was found that Devonian beds from the base of the Bloomsbury to the Mispeck are represented, and that the formation is much more extensive than was at one time supposed. These sediments are broken up, and in places highly altered by intrusive masses of diabase and rhyolite. Much of the Devonian in this district as well as east of St. John is highly altered, the shales assuming the aspect of schists and the Dadoxylon sandstone becoming a true quartzite.

In Carleton county certain areas of reddish conglomerate with grey sandstone and shale, which appear to the north of Woodstock and thence extend across the St. John river south of Hartland, were re-examined, and were found to belong to the Perry formation, the grey beds of the upper portion being also fossiliferous. It is also possible that a portion of the large Tobique outlier may belong to the Perry, but time and weather conditions did not permit of a close examination of this area.

The general outlines of the Cambrian rocks were not materially altered from those laid down on the published geological map of southern New Brunswick. In several places the lowest division of this system, known as the Etcheminian, was indicated, but the formation is too thin to be correctly delineated except on a large scale map. The areas best defined are those known as Division 2, which is in places highly fossiliferous, consisting of greyish and dark shales with quartzite bands. Division 3 is seen chiefly in the southern part of St. John city. The determination of the fossils obtained from the several divisions has been made by Dr. G. F. Matthew, and the results have been published in the Transactions of the Royal Society of Canada from time to time, as well as elsewhere.

THE TIN-BEARING LOCALITY AT NEW ROSS, N.S.

G. A. Young.

The field-work of the past season was devoted to an attempt to form some general conception of the igneous, geological history of New Brunswick and Nova Scotia. Though the results obtained are not available for immediate publication, considerable material for study was accumulated. Numerous traverses, largely over igneous rocks, were made in the two provinces, more particularly along the shores of Chaleur bay, through the Shepody mountains and in the vicinity of St. John city, in New Brunswick; across the Cobequid hills and near Arisaig, in Nova Scotia, and in the northeastern part of Cape Breton.

A brief visit while accompanying Mr. R. A. A. Johnston, of this staff, was paid to the locality of the reported discovery of tin ore in Nova Scotia, near New Ross, about sixteen miles inland from Mahone bay, on the Atlantic seaboard. The results of a very short examination seemed to indicate that the cassiterite occurs as an accessory constituent in a pegmatitic mass within a body of light-coloured, medium-grained muscovite granite. At the point of discovery a pit twenty feet deep had been sunk in the pegmatite, but when visited was filled with water. A certain amount of stripping in the immediate neighbourhood had failed to disclose further outcrops of the tin-bearing body, which seems to be of the nature of an irregular, acid schlieren, closely connected in origin with the containing muscovite granite. The pegmatite mass varies in grain, and in places is very coarse, with large quartz crystals at times a foot or more long, and embedded in kaolin or decomposed feldspar. Various boron- and fluorine-bearing minerals and others containing rarer elements have been recovered from the pegmatite and surrounding granite. The amount of tin present does not appear to have been accurately determined, and is doubtless small.

The light-coloured muscovite granite with which the cassiterite-bearing pegmatite is associated, was seen at a number of points in the neighbourhood and appears to be cutting a coarser-grained, biotite granite like the variety that throughout the eastern portion of Nova Scotia penetrates the gold-bearing sedimentary series. The more common biotite granite is usually rich in the dark mica and frequently is porphyritic with large crystals of feldspar often an inch in length.

In the neighbourhood of New Ross, various pegmatitic bodies, areas of fluorite-bearing granite, &c., have been reported and are possibly connected with the muscovite granite. From information obtained it seems probable that the muscovite granite with which the tin occurs at New Ross, or a similar rock, is rather widely distributed through the granitic regions of eastern Nova Scotia. It is thus possible that in some places they may be found to be tin-bearing, probably as at the original locality, in coarse-grained veins and irregular bodies.

LUNENBURG COUNTY, NOVA SCOTIA.

E. Rodolphe Faribault.

Mr. Faribault was engaged at headquarters from October 10, 1906, until June 19, 1907, when he left for Nova Scotia to resume his work in the field; he returned to Ottawa on October 12, 1907.

Office Work.

While in the office he completed for publication the manuscript covering the map-sheets of Prospect, Halifax City, Waverley, Elmsdale, Windsor, Ponhook Lake, St. Margaret Bay and Tancook Island. The Prospect and Elmsdale sheets have since been published and the others are in course of publication. A new feature brought out on these sheets is the marking in feet above sea-level of elevations of land, lakes and water-falls, which will certainly be appreciated and should prove useful, especially in estimating the water-powers available in the vicinity of Halifax, Windsor and the several mining camps of that region.

A special plan of the Brookfield gold district, on the scale of 250 feet to one inch, was also completed and is now being engraved. The plan of Malaga gold district has been published. These two plans complete the publication of 26 plans of the most important gold districts of the province which will be included in a general report on the gold fields, to be issued this coming year.

Mr. Faribault was assisted in the office part of the time by Mr. F. O'Farrell in the compilation of the inch-mile manuscript map from the surveys made a few years ago. The compilation has now been carried as far west as the Halifax and Southwestern railway, along La Have river, and north to the old Annapolis road, and it is hoped that by next spring the office work will have caught up to the field work. These maps are of immediate importance to the province, and their publication is now being pressed forward.

Field Work.

Of the field work accomplished in Nova Scotia during the summer of 1907, Mr. Faribault reports as follows:—

My instructions for the past summer's work were to complete the structural geology of the gold-bearing rocks extending along the coast from Chester to Bridgewater, and to make a special examination of the mineralized dikes of the New Ross granite region, where tin ore and other valuable minerals have recently been discovered, in order to prepare for publication the New Ross, Chester Grant and Mahone Bay map sheets. The last two sheets were completed but the New Ross sheet could not be, on account of the exceptionally wet weather experienced the greater part of the time, as well as the complicated nature of the structure of the gold-bearing rocks and the scarcity of the rock exposures, necessitating many more exploratory surveys to get the necessary data.

In accordance with instructions received, I left Ottawa with Mr. F. O'Farrell on June 19, 1907, for Mahone Bay, Nova Scotia, where I was joined by my two other assistants Messrs. J. McG. Cruickshank and D. S. McIntosh, B.A.Sc. Mr. McIntosh had already preceded me by going to New Ross three weeks earlier to observe and help if possible, in the developments being made on the John Reeves' tin deposit.

Mr. O'Farrell was engaged the greater part of the summer in making the surveys and taking the levels, with the transit and stadia, of 160 miles of railways and main roads which are to be used as control lines to lay down the surveys already made in Lunenburg and Queens counties, and to work out the elevations of hills, valleys, lakes and water-falls.

Carboniferous Limestone and Gypsum.

The field work consisted principally in completing the revision of the structural geology of the gold-bearing rocks lying along the Atlantic coast from Chester to Bridgewater and extending inland to the granite boundary, and in mapping out a succession of narrow deposits of limestone and gypsum of Lower Carboniferous age stretching out irregularly along the shore and over some inner islands, from Chester basin to Mahone bay.

A heavy mantle of glacial drift covers a great part of the rocks along the shore and for a certain distance inland, so much so, that gypsum was seen only in one place, on the southwest shore of Goat island, and the shell limestone could be observed only on Goat, Sheep and Stephen islands. The presence of these deposits in that locality was totally ignored by the inhabitants of the place, and may prove a source of profit now that they have been made known. They can be made out, however, by the symmetrical and circular, inverted, funnel-shape pot-holes, often attaining twenty feet in depth, which indicate the presence of gypsum, and by the irregular, hummocky, broken ground and the peculiar dark and luxuriant vegetation which characterize the limestone deposits.

Bits of bituminous coal handed to me were reported to have been found at Barkhouse mill and The Narrows, in Lower Carboniferous areas. A few prospecting pits were sunk at these places to depths of twenty to sixty feet, but without reaching bed rock. It is quite possible that small seams of coal might occur in that formation, as they have been found in many other localities in similar rocks in Nova Scotia, but it is very doubtful if they would be of sufficient thickness to be of economic importance. Moreover, it is not certain that the coal was carried there by natural agency.

Gold-bearing Rocks.

On account of the close and intimate relation existing between the occurrence of the gold-bearing veins and the anticlinal folds, it is of the greatest practical importance that the structure of the anticlines and synclines, the dislocations and faults, should be well defined on the map sheets and sections, in order to help and encourage intelligent research in new districts where rich gold float has been found, and also to guide in the development of mines that are in operation. In view of the economic and scientific importance of the structural geology great pains were devoted to it. In many cases to arrive at a satisfactory solution the same locality had to be repeatedly examined and surveyed, especially along the shore, in the vicinity of Mahone bay, where the rocks are concealed by extensive accumulations of glacial drift and the exposures are scarce. The difficulty is still increased by a strong development of the slaty cleavage which is sometimes so much pronounced as to obscure and often obliterate the planes of stratification. I have much pleasure in acknowledging that the successful carrying out of this work is in no small measure due to the energy and zeal displayed by my assistant, Mr. Cruickshank.

The gold-bearing rocks of the region examined have been forced into a succession of folds, almost parallel to each other, bearing a general northeasterly and southwesterly course. A detailed description of the structure of these folds and the faults affecting them could not be followed intelligently unless accompanied by a map and would be too lengthy for this report; it must, therefore, be deferred until a complete report is published with the maps.

The greatest width of the gold-bearing rocks in the area examined, measured at right angles to the folding, is forty miles along a straight line drawn from Cross island at the entrance of Lunenburg bay, to Dalhousie road. A cross-section made along that line would give eleven major anticlines and as many synclines, and a few other minor folds. Of the eleven anticlines, five are in the slate or upper division of the gold-bearing series which are generally not gold-producing, and six have brought up to the surface the quartzite ('whin') of the lower gold-producing division of the gold-bearing rocks. In the area under study four gold districts have been opened on four distinct anticlines; they are Spondo, Blockhouse, Indian Path and The Ovens, and of these Blockhouse has been by far the most productive. Detailed reports on these districts must be deferred until the surveys are all plotted and compiled.

At Centry, often wrongly called Centre, several large blocks of quartz sprinkled with gold have been found the last few years between Dares lake and the main road leading from Lunenburg to Bridgewater, three miles out from the former town, and much prospecting has been done to find the vein *in situ,* but until now without success. There is very little doubt that this float comes from the anticline passing immediately north of Dares lake, where the quartzites of the lower division have been brought up on a broad elliptical dome, three miles long by one mile wide, which is completely surrounded and overlaid by the slates of the upper division, and exhibits a structure very similar to that of the Caribou gold district. Much prospecting was done by Walter H. Prest to the north of the float, on the south limb of the quartzite dome, and several interbedded veins were discovered, but no gold was found in the veins or the drift, showing that the gold-bearing vein is further south. It will probably be found to occur in the slate, near its contact with the quartzite, where the maximum amount of movement and fissuring should have taken place, and it may cut the stratification at a slight angle, like the famous Lake lode, which was worked at Caribou to a vertical depth of over one thousand feet.

An examination was also made of the places where gold was reported to have been found, and in nearly every case they proved to be on, or in close proximity to, an anticline. The knowledge acquired in the study of the geological structure of the region often led to useful and practical information regarding the mineral deposits visited and, wherever possible, this was furnished on the spot directly to those entitled to it. In this manner much benefit is often derived from the work accomplished in the field which is not made public, for the results may not possess general interest and perhaps do not appear in the reports.

New Ross Tin Deposits.

The boundary line between the gold-bearing rocks and the granite was carefully traced from Goat lake, on the shore of Mahone bay, to Dalhousie road. As stated above, it was found impossible to complete this summer the revision of the granite area extending to the north. On account, however, of the importance of the recent discovery of tin ore and other valuable minerals in the granite at New Ross, a few days were spent in the examination of these deposits. This being the first discovery of tin ore in anything like economic quantities made *in situ* in Canada, it might be opportune to record it here in detail.

As early as 1868 tin is reported by Professor How to have been found at Tangier by W. Barnes, in a sand composed of quartz and decomposed feldspar, and Dr. E. Gilpin also obtained it in panning gold in the same locality. It was also reported at Shelburne, by J. Campbell, at Rawdon, by Harry Piers, and at Country Harbour and Malaga. Such finds were all connected with drift material.

In 1903, the writer surveyed geologically the New Ross region and reported in the Summary Report for that year the occurrence of pegmatite dikes bearing minerals of economic value, and recommended the locality as a promising field for prospecting.

In the Summary Report for 1906, a reference is again made to the ore-bearing character of the granites of that region, and to a report that tin ore had been found by Charles Keddy, at Lake Ramsay. But this find could not be verified, as samples brought then from that locality and examined for tin proved to be only minute crystals of zinc blende.

Mr. Harry Piers, curator of the Provincial Museum, accompanied by Mr. M. H. McLeod, visited the locality in November, 1903, and reports (Report, Dept. of Mines, Nova Scotia, 1906, p. 91) that the presence of pieces of quartz crystals, on the surface, led John Reeves, the owner of the land, and Benjamin Meister, to dig a small pit in wood land a short distance southwestward of Mr. Reeves' house; the site of the pit being about three-eighths of a mile south of the Dalhousie road, and three miles west of New Ross, Lunenburg county, N.S. In digging this pit, kaolin and large crystals of quartz were encountered, with which was associated some purplish-black fluorite.

Charles Keddy, of Lake Ramsay, who had been prospecting for tin ore in that neighbourhood for some years, in examining Mr. Reeves' prospect, found a dark mineral which he brought to Halifax in the middle of October, and this, on examination, proved to be cassiterite, the tin oxide. The property was thereupon taken up on October 22, under licence to search, by John Reeves, Benjamin Meister, Charles Keddy and E. E. Bishop.

Last winter samples of ore from the Reeves' prospect were received at different times by the Survey, and upon examination by Mr. Johnston they proved to contain, besides cassiterite, scheelite and wolframite, two valuable ores of tungsten, also amblygonite, an ore of lithium new to Canada, and other less important minerals.

Early last spring M. J. O'Brien and Neil A. King acquired an interest in the property and the latter took charge of the development work.

On the first of June, my assistant, Mr. McIntosh, was sent to New Ross, where he remained three weeks to observe the development, and to examine and collect samples while the shaft was being sunk. The New Ross deposits were again visited in August by the writer, in September by Mr. McIntosh, in October by Mr. R. A. A. Johnston, and in November by Mr. Johnston and Dr. Young. The material taken out was thus closely examined by officers of the Survey as the development progressed; a large number of specimens were collected and sent to the laboratory of the mineralogist for determination, and the operators were kept informed as to the nature and value of the ore extracted. Mr. Johnston has not yet completed his laboratory work, but his report will be published shortly and should prove very valuable to those interested, as several of the minerals discovered may prove of even more economic value and importance than cassiterite. From the results of Mr. Johnston's determinations up to date, the following minerals have been found to occur in the granites at New Ross: cassiterite, monazite, one of the columbite minerals, durangite, amblygonite, a lithium mica probably lepidolite, wolframite, scheelite, hubnerite, molybdenite, zinc blende, beryl, apatite, tourmaline, fluorite, pyrolusite, manganite, limonite, hematite, magnetite, siderite, bismuthinite, argentiferous galena, copper, iron and arsenical pyrites, kaolin and fire-clay, crystals of black smoky quartz, large crystals of white, smoky quartz, some of which measured twenty-seven inches long by ten inches thick. It may be remarked that, of these minerals, amblygonite and durangite are new to Canada; monazite and columbite are ores of rare metals used in the manufacture of the Nerst electric lamps; lepidolite and amblygonite are valuable ores of lithium; wolframite, scheelite and hubnerite are the three ores of tungsten used to harden steel; molybdenite and bismuthinite are also used in certain alloys; and clear, unflawed beryl crystals are precious stones.

At the time of my visit, on August 7, the King pit on the Reeves' tin deposit was eighteen feet deep, and measured twelve feet long by ten feet wide. The deposit is a pegmatitic segregation in the ordinary light grey granite of that region. It is composed of crystalline masses of feldspar enclosing very large crystals of smoky quartz with a little mica and other associated minerals, included in the list given above. The feldspar constitutes the greater part of the dike. The large quartz crystals, the fluorite, the tin ore and other associated minerals occur chiefly in zones about the middle of the dike, in feldspar generally much decomposed. There is no well defined foot or hanging wall. The strike of the dike is N. 65° E., and the dip is to the northwest and varies from 75° at the surface to 60° at the bottom of the pit. At the outcrop the dike was about eight feet in width and twelve feet in length, but the development shows that at one end at least it extends farther to the northeast under a cap of granite. The deposit appears to be what is often called by miners a 'blow-out.' It is probably the result of deep solfataric action and it should extend to a great depth. The results obtained so far should be considered very satisfactory and they warrant much greater development.

It may be interesting to know that two miles north of the tin discovery a small area of quartzites and slates of the gold-bearing rocks occurs followed farther east by a much larger area, both of which are all surrounded with granite. Gold has been found in quartz veins in these rocks.

The tin discovery has led to a good deal of prospecting in the vicinity of New Ross, with the result that several pegmatite, porphyry, aplite and quartz dikes bearing economic minerals have been discovered. Specimens from some of these collected last summer or sent directly to the Survey's laboratory, proved upon examination by Mr. Johnston to contain valuable minerals, which have been included in the list given above.

Traces of tin ore were identified in a few small specimens taken from a pegmatitic dike, twenty-four feet thick, discovered a mile north of Nevertell lake, on a tributary of Gold river, six miles south of Reeves' tin discovery.

Bismuthinite and molybdenite were found in a dike of quartz and aplite, one mile south of New Ross corner.

Ores of tungsten and rare earths were discovered on Dr. Lavers' and Frank

Boylen's claims, in a dike of pegmatite, twenty feet wide, situated one mile east of New Ross corner.

Reference has already been made in a previous report to the occurrence of a vein of molybdenite on Larder river, one and one-half miles southeast of Reeves' tin discovery, and to sphalerite and fluorite, on Lake Ramsay; and the manganese mine at Wallaback lake, some five miles northward of New Ross, is well known.

THE LARDEAU DISTRICT, BRITISH COLUMBIA.

R. W. Brock.

The instructions for the past season were to proceed to the Lardeau district and complete the work necessary for the publication of a map of the strip of country adjacent to the Columbia and Lardeau valleys from Revelstoke to Kootenay lake. Similar work had been completed, in 1904, as far as Poplar creek, so that the surveys to be accomplished this season lay between that point and Kootenay lake. This work being finished, the balance of the season was to be spent in Rossland to complete the study of that camp. Mr. Boyd, who, as in previous years, was associated with me as topographer of the party, was further instructed to start topographical work in the Similkameen district where field work was being prosecuted by Mr. Camsell of this Department.

Concerning his work, Mr. Boyd reports as follows:—

'I left Ottawa on June 4, for the Lardeau district, and was joined at Brandon by Mr. Shirley King, my assistant for the season.

'The first two weeks in the field were spent in occupying camera stations on some of the lower ridges and in selecting a suitable locality for the measurement of a base line to check the triangulation of the district, brought down from a base at Revelstoke, eighty miles distant. After the work in the Lardeau was fairly started, I left on June 21 for the Similkameen, returning, after starting the topography there, to the Lardeau on July 1.

'The topographical work in the Lardeau was carried on by the photographic method, and although the season, especially during the months of August and September, was very unfavourable for work on account of the almost continuous rain, yet enough information was obtained to map the strip of country lying between Poplar creek and the north end of Kootenay lake. This strip, which has an average width of about twenty miles, is an extension, in a southeasterly direction, of the country mapped during the seasons of 1903-4.

'The triangulation was carried down Kootenay lake to Kaslo in order to connect with the West Kootenay map sheet.

'The work in the Lardeau was brought to a close on September 19, owing to the unfavourable weather conditions. The remainder of the season until October 4 was spent in Rossland completing the work on the 1,200-foot map of that area, after which I left for Ottawa.'

During the months of June and part of July I was on leave of absence in northern Ontario. I joined Mr. Boyd at Poplar creek the first week in August. After looking over some of the claims about Poplar we proceeded to examine the basin of Cooper creek, after which we carried the survey down Kootenay lake to Kaslo. We were joined on September 3 by Dr. Low, and went with him up the Duncan river to Haleys. From Haleys, after Dr. Low's return, we proceeded to Hall creek, but weather conditions continued so unfavourable that it was considered advisable to remove to Rossland, having obtained enough information to proceed with the publication of the

Lardeau map. The work at Rossland was completed by October 4, and I returned east.

The country explored this season, like all the Lardeau, is extremely rugged. The mountains are lofty, some of them, as Cooper mountain and that at the head of Hamill creek, exceeding 10,000 feet in elevation. They are usually studded with glaciers and snow-fields. The streams entering the head of Kootenay lake and the Lardeau and Duncan are rapid torrents, debouching from picturesque canyons, even in the rapidly disintegrating phyllites. Frequently they have their sources in glacier-fed tarns.

Some of the cirques are cut in stratified rocks whose beds are of varying hardness. The result is a ridged cirque, the parallel lines of ridges traversing the cirque marking the strike of the rocks which in most cases happens to be across the cirques.

The northern faces of the mountains are usually precipitous ; the southern, being exposed to the sun and consequent temperature changes, more frequently have slopes corresponding to the angle of rest of the disintegrated fragments.

A frequent phenomenon on these slopes is the snow 'moraines.' These are usually crescentric mounds about five feet high, of small rock fragments and soil, which seem to form at the foot of snowbanks. All but the higher peaks show strong evidences of glaciation.

Land suitable for ranching occurs in the Lardeau and Duncan valleys, but only a limited acreage is as yet under cultivation.

Timber suitable for local purposes is to be found almost everywhere except, of course, at the higher elevations. Up the Duncan valley fine timber occurs, a number of companies have secured timber berths and preparations for lumbering operations are being made.

The high altitude tamarack, a comparatively rare tree, is abundant in this district about timber-line.

The geology of Poplar creek was described in the Summary Report for 1904. Very little development work has been done here since that time, so that it has not yet been satisfactorily demonstrated whether there is pay ore in this camp or not. Some rich, but so far small, pockets of gold-bearing material have been found.

On the Hecla claim on Rapid creek a shaft forty feet deep has been sunk on a quartz vein which has a width of about six feet at the bottom of the shaft. The quartz is rusty, with decomposing siderite. A tunnel, which was in about 253 feet at the time of our visit (September 9), had not intercepted the vein. Later in the season rich samples of auriferous quartz were found on a claim south of Poplar creek.

The arsenopyrite-bearing country rock which in places at least is auriferous, has not yet been systematically prospected, so there is still a possibility that somewhere it may be found to be of pay grade.

The rocks south of Poplar were also described in a general way in the Summary Report for 1904. They consist of a sedimentary series made up of slates, limestones and quartzites usually somewhat metamorphosed, invaded by dikes of gabbro, metamorphosed to greenstone-schists. At a few points more recent basic dikes are seen cutting these formations. Still younger granite intrusions break through and greatly disturb and metamorphose those older formations, sending out dikes of aplite and pegmatite between the beds and across the formations. Where highly altered, the sedimentary rocks and older intrusives become micaceous, chloritic, garnetiferous and calcareous schists, crystalline limestone or marble, micaceous quartzite, &c.

Just at the head of Kootenay lake the rocks form a low anticlinal arch with a slight plunge northward. The almost horizontal dip in the centre of the valley rapidly changes to steeper angles on the limits of the anticline on either side, and in a short distance from the valley becomes highly inclined, overturned, squeezed into tight S folds and faulted. On the Cooper Creek slope the prevailing dip will be, therefore, westward; on the Hamill Creek slope, eastward.

The sedimentary series, with included greenstone schists, and, especially near the head of the creek, granite dikes, extends to the head of Cooper creek where the granite massive, which forms the divide between the Lardeau and Columbia river, is encountered. Approaching the granite the sedimentary rocks are much contorted, crinkled on both a large and a small scale, and frequently faulted. Quartz is developed, especially as bedded veins and often in the saddles or inserted saddles of rock folds.

On the Great Britain claim at the head of the south fork of Meadow creek and at the north branch of Cooper creek, a considerable amount of work has been done, one tunnel having a length of 300 feet run in to prospect quartz 'veins' exposed on the cliff a short distance above the tunnel mouth. Some good ore has been obtained from the 'veins'—grey copper in kidneys in a quartz gangue.

The relationship of the quartz to the rocks is suggestive of a saddle reef, but complications are introduced by faulting, so that following the ore is difficult. On the opposite side of the gulch another tunnel has been run in 150 feet to develop a quartz lead mineralized with pyrite, siderite and sericite. Above this tunnel on the summit of the hill, bedded veinlets of quartz are abundant in the phyllites.

Up the south branch of Cooper creek, above the second forks, is an outcrop of acid granite strikingly porous (miarolitic). The sedimentary rocks invaded by this granite include some black limestone bands, some of which are altered to white marble, and some are beautifully interbanded with fine slaty layers.

A little farther up the south branch, on the west slope of the valley, is the Copper Cliff group of claims, on which some work was being done. On the sides of a little gulch the exposed rocks are rust-covered from decomposing sulphides. The country rocks consist of greenstone and banded sedimentary rocks, which are upturned to an almost vertical position, with intruded sheets or dikes of granite-porphyry. Some of these are about, if not quite, parallel to the strike of the sedimentary rocks. (If they have been intruded between the strata they should be called sheets, but as it is not certain that this is the case, for any great distance, the commoner term dike may be employed). Near the dikes, and parallel to the strike of the rocks, are several bands of ore. One band, about two feet wide, is exposed on the trail to the main exposure. The second, on which a crosscut tunnel was being run, has a width of three feet, then a horse of dike was run through, with ore again on the other side. The face of the tunnel was still in ore, several feet beyond the dike. Across the gulch, near a little canyon, a couple more small bands of ore were exposed. The ore, which could not be traced for any great distance up the mountain (and below its outcrops the slopes are wash covered), seems to be confined to the neighbourhood of the dikes. It consists of pyrrhotite, chalcopyrite, often interbanded with the pyrrhotite, a little zinc-blende, with, in places, a considerable amount of calcite gangue. Most of the gangue is, however, silicified rock (jasperoid) and biotite-schist. On the north side of the canyon some pyroxene-like mineral is also developed in the gangue.

The ore is said to run low in gold but to carry some silver; the main value is in the copper, which, however, is variable.

The work done was insufficient to enable an opinion to be formed as to the percentage of copper the ore was likely to carry and the amount of ore that might be developed. The deposit is interesting, being a unique type in the Lardeau, where practically all the known lodes are either auriferous or silver-lead quartz deposits, in which chalcopyrite is inconspicuous and tetrahedrite is the only abundant copper-bearing mineral. The Copper Cliff ore, on the other hand, is more like some of the ores in the southern part of West Kootenay, such as the Rossland camp. This resemblance consists not only in the association and dominance of pyrrhotite and chalcopyrite, but in the biotitization and silicification of the associated country rock.

The main difference between this and the other Lardeau deposits, outside the ores, is the number of granite-porphyry dikes occurring here and the metamorphism of the sedimentary rocks adjacent to them. There is a strong probability of a genetic relationship between those dikes and the ore deposits.

The rocks of the Duncan river to Hall creek are phyllites, hornblende and mica schists and gneisses, with a few limestone and quartzite bands.

The rocks up Hall creek are somewhat similar but less metamorphosed. A heavy band of quartzite several hundred feet thick constricts the creek into a canyon. Above this to the 'lime dike,' near the head of Hall creek, the rocks are graphitic phyllites, with occasional bands of limestone and green chloritic schists. Small quartz veins cut these rocks in an intricate way and silicify them in the neighbourhood of the veins.

The Bannockburn claim on the south side of Hall creek, just below the 'lime dike,' was once worked, but has been neglected the last few years. The work consists of numerous open cuts along a vein exposed on a rock bench, and a tunnel run in to crosscut this vein from below. The vein can be traced for several hundred feet and seems to occupy the contact between a rusty, thinly fissile schist (west wall) and a limestone band (east wall). It varies greatly in width from a mere streak to, at one point, several feet of solid ore. The ore consists of galena, zinc blende and chalcopyrite, weathered on the surface to rusty oxides and carbonates. The tunnel has been driven in ninety feet to a silicified and slightly mineralized band of rock which has been followed about one hundred feet, without encountering any ore. It is doubtful if this tunnel has been driven far enough, as a crosscut, to catch the vein, and there is as yet no proof that the vein is only superficial.

In this part of the country where the rocks are so badly folded and the veins show a tendency to be bedded (i.e. conform to the bedding planes of the rock) it is very risky undertaking expensive work to crosscut them at depth, without first having followed them down, and thus accurately determined their position. On account of its topographical character most of the work so far done in this part of the country consists of crosscut tunnels that have rarely encountered the veins. So that although there are some good surface showings, it is in most cases still uncertain whether they extend downwards, and if they do, whether the values hold.

Some work was being done on the Wagner claim, mostly in the nature of preparations for serious exploration. This prospect was described in the Summary Report for 1904. The tunnel is now said to be in 100 feet with a forty-foot crosscut. From the tunnel a winze sixty-five feet deep has been sunk and from the winze a twenty-foot crosscut has been run. The upper crosscut is said to have encountered an eight-foot ledge which in the lower crosscut is said to have widened to ten feet.

The property was being closed down for the winter at the time of our work on Hall creek, and as it had been examined in 1904, and was now snow-covered, it was not revisited.

On the Red Elephant claim, on the north side of Hall creek, near Porcupine flat, is a ledge of siliceous material holding pyrite and chalcopyrite, which crosses the strike of the graphitic phyllite country rock, in a northeasterly direction. A band of limestone occurs just east of the workings. The ledge, on which a couple of small tunnels were being run, has a width of about ten feet. The sulphides are oxidized and leached out on the surface, leaving the pitted, honeycombed quartz. This material, on panning, shows very minute colours of gold and is said, by the prospectors working the claim, to assay $20 to $30 a ton in gold.

There are a number of claims up the Duncan river, but very little development work is being done. The natural difficulties, due to the rugged nature of the country and the lack of transportation facilities, make such work arduous and expensive. Now that lumbering is to be started in this valley it will be made more accessible, which no doubt will result in increased attention to this district on the part of prospectors.

Hamill creek enters the Duncan river from the east, a little above the head of Kootenay lake, through a picturesque narrow box canyon, one of the finest in this part of the country.

The grade built in 1899 by the Great Northern Railway from Argenta on Kootenay lake to Howser lake is used as a wagon road, and from it a wagon road about three miles long has been built at considerable expense through the Hamill Creek canyon to the concentrator of the Argenta mines. The fine rock section exposed on the walls of the canyon is thus easily accessible.

Small landslips have blocked the road in places so that it can now be used only by saddle and pack horses, and unless it is looked after will soon be impassable even for pedestrians.

From the Argenta concentrator a trail extends to the head of Hamill creek across the divide and down Toby creek to a wagon road into the Windermere district.

ROCKS OF HAMILL CREEK.

Along the Duncan the rocks are schists with a low easterly dip. In the canyon the first rock exposure is limestone, and black argillites with interbanded aplite sheets. The altitude of the beds has become more steeply inclined to the east; crystalline limestone, slates, phyllites, with occasional green chlorite-schists and quartzites are the principal rocks seen in this section. Some of the lime bands are very heavy, but the thickness of the individual rock members is much exaggerated by the crumpling and folding which becomes pronounced a short distance up the canyon. Above the Argenta concentrator a band of quartzite seventy-five feet or more thick is exposed, and beyond this the rocks are more metamorphosed, being of pronounced schists, of which one studded with garnets is abundant.

The Argenta mine is situated on the north flank of the gorge of Hamill creek just above the canyon, about 1,500 feet above the level of the creek. There are two veins on the property of this company, the Clinton vein which strikes N. 10° W., with a dip of 55° west, and the Mabel-Nora vein striking about N. 8° W., 450 to 500 feet east of the Clinton vein.

The Clinton is a quartz vein carrying chalcopyrite, some gold, and silver to the extent of about one ounce of silver to each per cent of copper present in the ore. The vein occurs in a fissured zone about ten to twenty-five feet in width, with a well marked slickensided hanging wall. The shattered material of this zone forms the ledge material, in which the ore, generally about one foot in width, though widening to two and a half feet, is developed, more frequently probably along the foot wall of the fissured zone. The Mabel-Nora vein is a silver lead vein. The country rocks are limestone phyllites and chlorite schist. Most of the work has been done on the Clinton vein.

No. 1 tunnel starts from a small gulch as a crosscut to strike the ledge, which was encountered in about forty feet and then drifted on. No. 2 tunnel, about 100 feet below, also starts as a crosscut from the gulch and taps the ledge at 150 feet, which is then drifted on for several hundred feet. A rise from No. 2 tunnel has been put through on an ore shoot to No. 1 tunnel and the surface.

No. 4 tunnel about 250 feet below No. 2, and 1,500 feet in length, is the longest in the mine. It is driven one thousand feet along the hanging wall slip and then turns as a diagonal crosscut for the Mabel-Nora vein.

No. 6 tunnel is a short one, also on the hanging wall slip.

Nos. 3 and 5 are mere open cuts.

No satisfactory ore bodies have been located below No. 2 tunnel.

In the creek bottom below the mine, the compressor plant is located. It is operated by water-power, furnished by a flume, half a mile long, supplied by water from Hamill creek, with a small wing dam at the intake. It discharges its water under a 115-foot head to a Pelton wheel, directly connected to the shaft of a one-half 10-drill Canadian Rand compressor.

The mine was not being operated at the time of visit, having been shut down early in the summer. The manager, Mr. Garde, was still in charge of the property.

No ore can be shipped until a tram connects the mine with the wagon road, and it is doubtful if this will be installed unless a greater tonnage of ore is developed.

ROSSLAND.

Among the more important developments in this camp during the year may be mentioned the sinking of the LeRoi and Centre Star shafts to deeper levels, the Centre Star bottom level (14th) having an elevation of 1,932 feet, about 1,750 vertically below the collar of the shaft, or little more than 500 feet above the Columbia at Trail. The 11th level of the Centre Star has been extensively developed and gives promise of being about the best level in the mine. The 12th level has not been as promising, but it is not yet thoroughly prospected. The 13th and 14th are still in an embryonic stage.

The Iron Mask and Idaho claims have been taken over by the Consolidated Mining and Smelting Company and are being developed largely from War Eagle and Centre Star workings. A shaft is also being sunk on the Idaho. While not very far advanced in development, and while, as in all the mines, ore is not always where it might have been expected, or hoped for, some good ore has been encountered.

A number of dikes and faults converge about the line between the War Eagle and Iron Mask, and as several veins are present, the result is rather a perplexing number of vein sections, and it is as yet impossible to say just how many or what veins are represented.

The War Eagle is now being operated largely from the Centre Star shaft, electric locomotives being used underground for haulage. Some new ore bodies of good grade have been located in this mine as a result of the development work.

The large new Nordburg hoist and the other improvements at the Centre Star headworks, mentioned in last year's Summary, have been installed and are working satisfactorily.

On both the LeRoi and LeRoi No. 2, the continued development work has demonstrated greater regularity and continuity in the veins and ore bodies than the earlier work suggested.

West of the Josie dike, in the Black Bear workings of the LeRoi, the extension of the biotite rich porphyritic monzonite has been encountered. This rock is exposed on the Red Mountain Railway in a cut just west of the Josie ore veins. It is certain that it does not extend northward far above the track either on the surface, nor, in all probability, underground. Its southern limit is not known, the surface being wash-covered and no underground workings or drill holes having entered this area. But, from its abrupt northern termination and its contacts with the ordinary country rock, the probability is that it may have the form of a plug, intrusive in the country rock, rather than that of an extended dike. On the west side of this mass, the White Bear Mining Company have located a body of ore about twelve feet wide consisting of almost solid pyrrhotite and chalcopyrite running one to one and a half per cent copper and two to three dollars in gold per ton.

Some work is being done on the Spitzer, under bond to the LeRoi mine, and diamond drilling has been undertaken to prospect the ground between the Spitzer and the LeRoi, which was recommended in last year's Summary Report as promising ground for exploration.

Work has been resumed on the California and Giant, the most important line of development being the sinking of a shaft from the old California tunnel to pierce the overlying stratified rocks and from which the (presumably) underlying porphyrite may be prospected for the continuation of lodes developed in the adjoining LeRoi No. 2 mine, whose workings in porphyrite extend beyond the surface contact of the porphyrite and stratified rocks.

Work was also being started on the Jumbo, and several of the smaller properties were having some work done on them by lessees.

Scarcity of fuel and coke in the early part of the year, a scarcity of labour, an advance in wages and then the sharp drop in the price of copper, have all contributed to retard production, which will probably show a falling off as compared with last year. It is unfortunate that while the prices of metals were high, the production had to be restricted.

At the time of writing a despatch from Rossland states that the Miners' Union has voluntarily consented to a reduction of wages, to the scale obtaining prior to July 1, which, it is expected, will cause some improvement in the situation.

THE CHEMICAL LABORATORY.

F. G. Wait.

Conformably with the practice of former years, the work performed in the chemical laboratory during the twelve months ending November 30, 1907, has been confined almost entirely to the examination or analysis of such minerals, ores, &c., as were thought might prove of economic importance.

The specimens brought in during the year totalled 1,075, being an increase of 300 over the number examined in the preceding twelve months. They have, taken collectively, been of the usual widely varying character, but may, for present purposes, be conveniently classed as follows:—

1. Different varieties of fossil fuel from:
    - (*a*) Nova Scotia—The Richmond mine, Cape Breton county.
    - (*b*) Alberta—
        - i. Sec. 16, tp. 6, R. 30; W. of 4th meridian.
        - ii. Sec. 9, tp. 17, R. 17; W. of 4th meridian.
        - iii. Sec. 30, tp. 38, R. 23; W. of 4th meridian.
        - iv. Sec. 28, tp. 15, R. 27; W. of 4th meridian.
        - v. Bow river, at a point some twenty miles south of Brooks station, C.P.R.
        - vi. Cascade basin, six samples.
        - vii. Costigan basin, three samples.
        - viii. Scalp Creek area.
        - ix. South Brazeau river, eight samples.
        - x. Prairie creek, two samples.
        - xi. Bighorn river, three samples.
    - (*c*) British Columbia—
        - i. Morice river, Skeena district, four samples.
    - (*d*) Yukon—
        - i. Coal creek, Sour Dough mine.
        - ii. Lewes river—
            - (*a*) Five Fingers mine, two samples.
            - (*b*) Tantalus butte, three samples.

2. Iron ores from:
    - (*a*) Nova Scotia—
        - i. Limonite from Indian harbour and from Caledonia, Guysboro' county.
        - ii. Hematite from Ben Eoin, Bras d'Or lake, Cape Breton county and from Black river, Richmond county.
    - (*b*) New Brunswick—
        - i. Hematite from near Dorchester, Westmorland county.

(c) Quebec—
  i. Hematite from L. 1, R. 3, of tp. of Dunham, Missisquoi county.
  ii. Magnetite from Big Pipestone rapid, Quinze river.

(d) Ontario—
  i. Hematite from township of Somerville, Victoria county.
  ii. Magnetite from a point ten miles west of Savanne lake, Thunder Bay district.
  iii. Limonite, ten samples, from townships of Oakley and Draper, Muskoka district.

(e) Manitoba—
  i. Hematite and limonite from near Deepdale, just west of Roblin, along the line of the Canadian Northern railway.

(f) Saskatchewan—
  i. Clay iron-stone from Pas mountain.

(g) Alberta—
  i. Clay iron-stone from:
    (a) Bow river, just west of Knee hill.
    (b) Red Deer river, two miles north of Brooks.
    (c) Two miles north of Burnus siding.

3. Iron sand, from:
  (a) Quebec—Rouge river, Buckingham township, Labelle county.
  (b) British Columbia—from the Fraser river, at:
    i. Big Bar.
    ii. Little Big Bar.
    iii. Lillooet bridge.
    iv. Alexander creek, a tributary of the Fraser.

4. Copper ores, from:
  (a) New Brunswick, Albert county.
  (b) Quebec—
    i. Bonaventure county, Matapedia township.
    ii. Drummond county, Lot 21 of township of Wickham.
  (c) British Columbia—
    i. Highland valley, Kamloops div.
    ii. Mud creek, a tributary of the Chilcotin river.

5. Antimony ore, from near Whitehorse, Yukon.

6. Nickeliferous pyrrhotite from:
  (a) Quebec, Pontiac county.
  (b) Ontario—
    i. Nipissing district, townships of Craig, Moncrieff and Springer.
    ii. Renfrew county, township of Pakenham.
    iii. Victoria county, township of Somerville.

7. Limestones and Dolomites from:
  (a) Nova Scotia, Dorton bridge, rear of Port Hastings, Inverness county.
  (b) Quebec, township of Rawdon.
  (c) Ontario, Lot 6, Con. IV., Stormont township, Stormont county.

8. Calcareous Marls from:
    (*a*) New Brunswick, Restigouche county, Martin lake.
    (*b*) Quebec, Wright county, township of Cantley.
    (*c*) Ontario, Huron county, township of Morris.
    (*d*) Manitoba, vicinity of Dauphin.
    (*e*) Alberta, vicinity of Didsbury.

9. Brick and pottery clays from:
    (*a*) Nova Scotia—
        i. Cape Breton county, near junction of Meadows and Morley roads, in the vicinity of Woodbine post office.
        ii. Guysboro' county, Lower Salmon river.
    (*b*) New Brunswick—
        i. Flower cove, Grand lake.
        ii. Rothwell Coal Company's property.
        iii. Westmorland county, vicinity of Salisbury.
    (*c*) Ontario—
        i. Carleton county, Lot 17, Con. III., of March.
        ii. Stormont county, Lot 10, Con. VI., of Stormont.
    (*d*) Saskatchewan—
        i. Town of Vonda.
        ii. Six miles above Medicine Hat, on bank of Saskatchewan river.
        iii. Sec. 28, tp. 36, R. 7, W. of 3rd.
    (*e*) Alberta—
        i. Vicinity of Wetaskiwin.
        ii. Vicinity of Gleichen.
        iii. Sec. 25, tp. 25, R. 3, W. of 5th.
    (*f*) British Columbia—
        i. Vicinity of Ashcroft.
        ii. Minto mining district.

10. Natural water from:
    (*a*) Quebec—
        i. Wright county, R. 4 of West Templeton.
        ii. Wright county, Lot 6, R. 8, of Eardley.
        iii. Wright county, near Breckenridge station, Eardley township.
    (*b*) Ontario—
        i. Russell county, Lot 22, Con. X., of Clarence—nine samples.
        ii. Timagami mineral spring.
    (*c*) Saskatchewan—
        i. Carrot river, three miles above Sipanok channel.

11. Gold and silver assays, from the provinces of:
        i. Nova Scotia.
        ii. New Brunswick.
        iii. Quebec.
        iv. Ontario.
        v. Saskatchewan.
        vi. British Columbia.
        vii. Yukon.

12. Miscellaneous examinations :
    - i. Infusorial earth, from Glen Morrison, Cape Breton county, N.S.
    - ii. Calcareous tufa, from Kelowna, B.C.
    - iii. Phosphatic shale, from Chimney Corner, Inverness county, N.S.
    - iv. Tar sand and mineral tar, from several localities in Alberta and Saskatchewan.
    - v. Carbonaceous shale, from the vicinity of Springhill and New Glasgow, N.S.
    - vi. Iron ochre, from Torbolton, Carleton county, Ont.
    - vii. Silt, from east side of L. Winnipeg, opposite Elk island.

Of all the specimens examined, only a comparatively small number have been thought worthy of mention in the foregoing list, the remainder having been of particular interest to the individual owner only, to whom the necessary information was imparted at the time of calling, or by letter. Letters written number 496.

The laboratory was under the direction of Dr. G. C. Hoffman until his retirement from active service on April 1, 1907. Since that date I have been in charge, and have been ably assisted by Mr. F. Connor, B. Ap. Sc.

Acting upon instructions from Dr. Low, I spent a portion of the months of May and June in visiting the laboratories of Harvard College; the Institute of Technology in Boston; Columbia School of Mines, New York; the U. S. Mint, and the University of Pennsylvania, at Philadelphia; the U.S. Geological Survey at Washington; and the Lackawanna Steel Company at Buffalo. The object desired was to become acquainted with the methods and appliances employed at these larger institutions, with the view of the adoption of such as might prove advantageous in this laboratory. I was received everywhere with the utmost courtesy and was given every opportunity, not only of becoming personally acquainted with many of the foremost workers in this class of investigation, but also of observing and noting whatever appeared to be worthy.

REPORT ON WORK DONE BY M. F. CONNOR, 1906-1907.

Ores.	Gold and Silver.	Copper.	Lead.	Zinc.	Nickel and Cobalt.	Antimony.	Platinum.	Tin.	Iron ores.	Limestones.	Coals.
No. of determinations..	398	17	8	3	5	7	9	1	17	12	Seven coals approx. analyses and calorific determinations.
No. of samples...... ..	200	17	8	3	3	7	9				

Of the above eighty samples for gold and silver, seven antimony ores determinations are referred to in Mr. Wait's statement.

Assays of gold and silver ores were made on samples from Ontario; from Cobalt, Larder lake, Algoma, North Bay, Sudbury and Timagami district.

From Chibougamau, Pontiac county, Quebec.

From Brookfield, Middle river, Cape Breton.

From Skeena river, Omineca district, Fraser river and Yukon in the west.

Assays of copper ores from Lake Bennett (Yukon Territory), Lorraine township, Whitefish lake, Chibougamau, Cox-Heath and Cape Breton.

Antimony ores from Yukon Territory.

Iron ores (Bog), Muskoka, Ont., Pontiac, Que., and Alberta.

Coals, British Columbia and Alberta.

A considerable number of rocks of much interest and importance have been received for analysis from geologists of the Survey.

Arrangements are being made for carrying out such work, and a beginning has been made, rocks having been analysed for Dr. Adams, Dr. Daly and Dr. Dresser.

SECTION OF MINERALOGY.

Robt. A. A. Johnston.

The work in this section has been largely of a preliminary character; in the early part of the year, with the co-operation of Dr. G. A. Young, a short descriptive pamphlet was prepared to accompany the High School collections of 1907; the determination to make some radical improvements in the collections for High Schools and Collegiate Institutes necessitated a careful revision of the lists of species and localities as well as the elimination of a quantity of material which in the nature of things had been accumulated in past years and which had been found unsuitable for the purpose in view; the ever increasing popularity of these collections has not only made this attention necessary but imperative.

As will be seen from the subjoined lists a large amount of new material has been assembled during the past season; a few desirable species are, however, still unrepresented; in most instances this is due to the remoteness of or difficulties of access to the localities where suitable materials are to be found in sufficient abundance; these will receive special attention during the season of 1908, by the end of which it is hoped that the Department will be in a position to issue collections of Canadian minerals in every way creditable to it and highly suited to the educational needs of the institutions for which they are intended.

During the year a large amount of determinative work has been carried out; in addition to the determinations incident to the sorting over of material already in the Department eighty-six consignments have been received from persons in different parts ot the country involving the examination of some four hundred separate specimens; the number of letters received was 89 and the number sent out was 84.

A Stoe Reflexion-Goniometer has been added to the equipment.

The following mineral species are now for the first time recorded as occurring in Canada:—

Amblygonite, a fluo-phosphate of aluminum and lithium, from King's 'tin-lode' near Lake Ramsay, Lunenburg county, Nova Scotia; *durangite, a fluo-arsenate of aluminum and sodium,* from the same locality as the preceding species; *argyropyrite, a sulphide of silver and iron with a small amount of copper,* from the Foster mine, Cobalt, Ontario. A few others are still the subject of investigation.

My field work for the year was confined to a brief excursion, October 7-16, to the new mineral localities in the parish of New Ross, Lunenburg county, Nova Scotia, and to the antimony mines near Lake George in the parish of Prince William, York county, New Brunswick, from both of which places a number of interesting specimens were collected for examination.

Mr. R. L. Broadbent, who had been engaged with the Dominion Exhibition Commission at work at Foreign and Colonial Expositions, returned to duty in the Department in July, since which time in addition to discharging a large amount of Museum work he has been engaged in collecting minerals at a number of the more important localities in Northern and Central Ontario; Mr. C. W. Willimott superintended the assembling and labelling of the High School collections, and during the summer visited a number of localities in the Gatineau valley; Mr. A. T. McKinnon assisted in arranging and despatching the High School collections, and during the summer has collected a large amount of material from various points in Nova Scotia, Quebec and Eastern Ontario; the reports of these gentlemen are herewith appended.

The additions to the Museum consist as follows:—

Donations.

Per Dr. R. W. Ells—

Albert Manufacturing Company, Hillsborough, N.B.; Hon. C. J. Osman, Manager:—Albertite with gypsum.

James Robinson, Albert Mines, N.B.:—Albertite from Albert Mines, Albert county, N.B.

Cobbler-Sexton Mining Company, Woodstock, N.B.; J. Draper, Secretary:—Native gold in quartz, from parish of Northampton, Carleton county, N.B.

Per R. L. Broadbent—

Nipissing Mining Company, Cobalt, Ontario; T. R. Drummond, General Manager:—Native silver, native bismuth, niccolite, smaltite and cobalt ore showing arborescent markings.

O'Brien Mining Company, Cobalt, Ontario; T. Culbert, General Manager:—Native bismuth, argentite, chloanthite, breithauptite.

Buffalo Mining Company, Cobalt, Ontario; T. R. Jones, General Manager:—Argentite and native silver.

Black Donald Mining Company, Calabogie, Ontario; H. F. Meech, Manager:—Graphite, both in massive and in crystal forms.

T. Morrison, Bancroft, Ontario:—Sodalite, nephelite and apatite crystals from Dungannon, Ontario.

W. S. Morden and A. C. McLatchie, Belleville, Ontario:—Barytocelestite from Loughborough, Ontario.

Per Dr. H. M. Ami—

M. McLeod, Ottawa, Ontario:—Cleaved crystal of pyroxene from the township of Arundel, Argenteuil county, Quebec.

Per A. T. McKinnon—

W. G. Fairbairn, North Wakefield, Quebec:—Large twin crystal of pyroxene from township of Wakefield.

Dr. A. E. Barlow, Ottawa, Ontario:

Stromeyrite, argyropyrite and native silver in calcite from the Foster mine, Cobalt, Ontario; native gold in quartz from Mining Location T.R. 169, Nipissing district, Ontario; freibergite in quartz from the Silver Queen mine, Cobalt, Ontario; molybdenite and chalcopyrite from the Dreany Location, seventy-six and a half miles from North Bay, Timiskaming and Northern Ontario Railway; chalcopyrite from Mining Locations on Timber Limits 137 and 138, north of Massey, Algoma district, Ontario; massive specimen of chalcopyrite and niccolite from Hubert lake, Montreal river, Nipissing district, Ontario; hematite (specular iron) from west side of Silver lake, an expansion of the same river; native bismuth from the O'Brien mine, Cobalt, district of Nipissing, Ontario; pentlandite from Krean Hill mine, Denison tp., Ontario.

J. Obalski, Quebec:

Section of Chambord meteorite.

Charles Boylan, New Ross, N.S.:

Crystallized native copper with chabazite from Cape d'Or, Cumberland county, N.S.

Joseph Martin, Plantaganet, Ontario:

Calcite with rod of iron-pyrites.

H. A. Cameron, Ottawa:

Sphene with scapolite, from the township of Dorion, Wright county, Que.

Rev. G. Eifrig, Ottawa:

Five nodular concretions from near High Falls post office, Villeneuve, Labelle county, province Quebec.

Henry A. Rudin, Halifax, N.S.:

Manjak from Vistabella mines, Trinidad, B.W.I.

Exchanges.

E. Monaco, Portici, Italy:

Sal ammoniac, halite and volcanic ash, all products of the eruption of Vesuvius in 1906.

Collection by Officers of the Department.

Dr. A. P. Low:

Stromeyrite, argyropyrite and native silver from the Foster mine, Cobalt, Ontario.

E. R. Faribault:

Quartz crystals and amblygonite from Lake Ramsay, New Ross, Lunenburg county, N.S.

Charles Camsell:

Portion of silicified tree-trunk from Agate hill, B.C.

R. L. Broadbent:

Green fluorite with barite, calcite (Iceland spar), calcite crystals, hematite with stilpnomelane, from Madoc, Ontario; barytocelestite, from Loughborough, Ontario; nephelite crystals from Dungannon, Ontario.

Purchases.

Two specimens of native silver from Nova Scotia Mining Company, Cobalt, Ontario.

Massive specimen of silver-nickel ore from the Right-of-Way mine, Cobalt, Ontario.

The following educational institutions in Canada have been supplied with collections during the year. Unless otherwise noted the full 1907 collection of 145 specimens has been supplied:—

Province of Alberta—

High Schools:—Lethbridge; Medicine Hat.

Province of British Columbia—

High Schools:—Armstrong; Revelstoke; Vancouver; Victoria.

Province of Manitoba—
High Schools:—Carberry; Neepawa; Souris.
Other institutions:—St. Mary's Academy, Winnipeg.

Province of New Brunswick—
High School:—Moncton.

Province of Nova Scotia—
Academy:—Guysboro' (27 specimens).
Other institutions:—St. Ann's College, Digby.

Province of Ontario—
Collegiate Institutes:—Barrie; Guelph; Lindsay; Napanee; Perth; Renfrew; St. Thomas; Toronto Junction (9 specimens).
High Schools:—Arthur; Aylmer; Chesley; Eganville; Elora; Gravenhurst; Harriston; Hawkesbury; Kemptville; Lucan; Melbourne; Midland; Orangeville (12 specimens); Penetanguishene; Port Hope; Prescott; Smiths Falls; Trenton; Walkerton; Waterford; Wingham.
Other institutions:—University of Ottawa; Rideau Street Convent, Ottawa; Loretto Abbey (35 specimens), Toronto; Ryerson School, Hamilton.

Province of Quebec—
Laval University, Quebec, 3 specimens; College of Lévis; Classical and Commercial School, Rigaud, 54 specimens; McGill University, Montreal, 21 specimens.

Province of Saskatchewan—
High School:—Moosomin.

R. L. Broadbent.

In July I returned from Christchurch, New Zealand, where I had been in charge of the Canadian Mineral Exhibit at the International Exhibition.

While the exhibit there was not as large as those at Liege and Milan, yet it contained by far the largest and most complete collection of economic minerals on display. Of the 14,000 square feet of space allotted to Canada, 3,941 square feet were occupied by the mineral section. The minerals were arranged in table-cases and in pyramids, and where practicable, the various stages of reduction of the ores were illustrated from the raw material as it came from the mine to the finished product and articles manufactured from it.

The large display of silver-cobalt-nickel ore from the Cobalt mining district of Ontario created much interest amongst metallurgists and others interested in mining. The displays of nickel, asbestus, mica, corundum and graphite also attracted a great deal of attention, most of these minerals being novelties in New Zealand. Panels giving mineral statistics and other information in regard to Canadian mining enterprise were placed at various points of vantage.

The exhibition was a pronounced success and will be the means of drawing the peoples of the two Dominions into more intimate relations.

After my return in July I visited the Cobalt, central Ontario and Kingston and

Pembroke districts, and in addition to securing a large number of specimens for the Museum, collected the following materials for the educational collections:—

		Pounds.
Fluorite	Madoc	525
Talc (white)	Madoc	850
Hematite	Madoc	400
Lithographic stone	Marmora	500
Sodalite	Dungannon	400
Nephelite	Dungannon	400
Nephelite-syenite	Dungannon	400
Garnetiferous schist	Cardiff	450
Iron pyrites	Queensborough	500
Arsenopyrite	Deloro	500
Hornblende	Bridgewater	600
Actinolite	Bridgewater	250
Talc (green)	Grimsthorpe	250
Celestite	Bagot	600
Graphite	Brougham	500
Barytocelestite	Loughborough	450
Chlorite	Belmont	350
Chlorite-schist	Belmont	350
Niccolite and smaltite	Cobalt	500
Native bismuth	Cobalt	25 specimens

A series of marbles from the townships of Faraday and Dungannon.

Special thanks are due to Messrs. T. R. Drummond, T. Culbert and T. R. Jones, of Cobalt; to Mr. H. F. Meech, of Calabogie; to Mr. T. Morrison, of Bancroft, and to Messrs. W. S. Morden and A. C. McLatchie, of Belleville, for many courtesies rendered during the season.

C. W. Willimott.

During the early part of the year I was engaged chiefly in making up collections of minerals and rocks for distribution to educational institutions in Canada. Considerable time was also consumed in replying to inquiries regarding specimens that had been brought into the Department for identification.

My field work was materially interfered with through ill-health. I visited several localities in the township of Egan, Wright county, Quebec, at which mineral occurrences had been reported, but with one or two exceptions little of note was observed; quartz crystals were found abundantly in the schistose rocks at some points; some of these were very fine specimens; several localities where molybdenite had been found were also examined; development work was in progress at one of these places at the time of my visit; it is doubtful though whether the enclosing rock formation extends for any great distance; at one of the openings a vein of graphite was noticed running parallel with a vein of molybdenite six feet away.

A. T. McKinnon.

From June 24 to October 5, I was engaged in collecting minerals for the high school collections, and for this purpose visited a large number of localities in Nova

Scotia, New Brunswick, Quebec and Ontario. The following is a list of my collections for the season:—

		Pounds.
Red sandstone	Amherst, N.S.	1,100
Bituminous coal	Springfield, N.S.	243
Moss agate, trap, &c.	Two Islands, N.S.	330
Fibrous gypsum	Moose island, N.S.	660
Basaltic trap	Two Islands, N.S.	445
Barite	Five Islands, N.S.	520
Stibnite	West Gore, N.S.	125
Manganite	West Gore, N.S.	75
Siderite	Londonderry, N.S.	1,300
Limonite	Londonderry, N.S.	60
Stellarite	Stellarton, N.S.	200
Selenite	Elmsdale, N.B.	300
Graphite	Buckingham, Que.	475
Quartz	Buckingham, Que	1,000
Apatite	Portland, W., Que.	475
Scapolite	Grenville, Que	465
Wollastonite	Grenville, Que	940
Syenite porphyry	Grenville, Que.	400
Graphite	Grenville, Que.	465
Sandstone conglomerate	Soulanges, Que	480
Magnesite	Bolton, Que.	525
Chloritic schist	Stukely, Que.	430
Diopside	Orford, Que.	450
Calcite	Orford, Que	460
Pyrite and chalcopyrite	Ascot, Que	900
Serpentine	Thetford, Que	400
Chrysotile	Thetford, Que.	425
Chromite	Coleraine, Que	500
Bornite in quartz	Leeds, Que.	675
Limestone	Hull, Que.	500
Spinel	Bouchette, Que.	1,575
Jasper	Hull, Que	325
Marble	Hull, Que	325
Serpentine limestone	Hull, Que.	335
Serpentine	Hull, Que.	335
Marble	Litchfield	475
Sphalerite	Calumet island	600
Albite	Villeneuve, Que	950
Tourmaline	Villeneuve, Que	140
Edenite and magnesite	Grenville, Que	300
Rutile	Templeton, Que.	200
Idocrase	Templeton, Que.	375
Sandstone	Nepean, Ont.	500
Hornblende	Raglan, Ont.	270
Amazon stone	Cameron	500
Fluorite and calcite	Ross, Ont.	1,040
Perthite	N. Burgess, Ont.	500

In addition to the materials collected as above, Mr. Charles Camsell has collected for this section 280 pounds of silicified wood from Agate hill, B.C.

MEMORANDUM *RE* COAL TESTS.

Dr. J. B. Porter.

A systematic investigation of the coals of the Dominion has been undertaken by the Survey, with the assistance of certain specialists, and sufficient progress has already been made to justify the expectation that the main work on the coals of the Dominion will be completed by the end of next year.

The intention is to obtain a representative sample lot of coal from each important seam in each district, and to subject each of the samples so obtained to an exhaustive series of economic and chemical tests. The economic tests include coal washing, and, when necessary, dry cleaning, followed by boiler tests on the washed and also on the original unwashed coal. Other portions are to be treated in gas producers and the gas used in suitable gas engines provided with devices for measuring the power developed. It is proposed also to carry out competitive coking tests on washed and unwashed portions of such coals as are suitable for the manufacture of coke.

In connexion with the above economic tests a complete series of chemical analyses and calorimetry determinations will be made of all coals, and analyses will also be made of the products of each washing and coking operation and of the gases from the boiler and producer tests.

The Director of the Survey has been able to secure the co-operation of the Mining and Mechanical Engineering Departments of McGill University, and thus to obtain not only competent technical assistance and a trained staff of experts and mechanics, but also to get the free use of admirably equipped laboratories. The advantage of this last feature alone can be judged from the fact that it would cost between $100,000 and $150,000 to duplicate the laboratory and office plants and equipment which have been placed at the service of the Survey. Thanks to these arrangements, it has only been necessary to purchase one considerable set of apparatus, namely, a gas producer and gas engine plant of the most recent type. This has been installed in a temporary fireproof structure, which has been built close to the mining laboratories at McGill. In all other respects it has been only necessary to purchase certain special apparatus to supplement the McGill equipment.

The investigation is under the general direction of Dr. J. B. Porter, Professor of Mining Engineering, McGill University, who is also individually responsible for the sampling, coal washing and chemical work. The conduct of the boiler tests and producer gas engine experiments has been put in the hands of Mr. R. J. Durley, Professor of Mechanical Engineering, McGill University. The several portions of the work are conducted as follows:—

The economic tests above named are carried out on a scale of approximately 50 horse-power and for periods of not less than one day. This 50 horse-power scale has been adopted as being at once large enough to ensure practical service conditions, and yet small enough to be of value to the community which, in general, makes much more use of small than of large power plants.

Samples are taken by Mr. Theo. Denis, of the permanent staff of the Survey. Mr. Denis visits and examines each mine to be sampled, and has a ten ton lot of coal selected, sacked and shipped under his own personal supervision. In taking this lot he uses every precaution to secure average coal, and, as a check on the main lot, he personally secures a smaller sample which he seals and sends direct to the chemist.

The main sample, on arrival at the testing plant, is unsacked, crushed to go through a two-inch screen, mixed thoroughly, sampled for the chemist, and then resacked and set out for treatment.

This work, as well as the washing, the steam, and the gas power tests, is in charge of Mr. C. Landry, Chief Mechanic of the Mining Department.

The coking tests will be deferred until a later date, as it is desirable to first complete the general survey of the subject and analyse and test the coals as above outlined. It is proposed to have the coking experiments done under separate supervision at one of the large modern coking plants, as laboratory tests on coking have not proved reliable even when carried out on a very large scale.

The chemical work is done in Dr. Porter's private laboratory, which has been set aside for this exclusive service. In addition to the regular equipment of the laboratory, calorimeters by Ostwald and Boys have been procured, and such other special apparatus as has been found necessary to make the equipment as complete as possible for investigation on fuels. The chief chemist is Mr. Edgar Stansfield, M. Sc.

Owing to the very tardy deliveries of some of the machinery and apparatus ordered from abroad, and to delays due to the disastrous fires which occurred at McGill last April, it was impossible to get work started as promptly as had been hoped, but, nevertheless, the results for the year are very encouraging. Mr. Denis has visited Nova Scotia and New Brunswick and has taken nineteen samples, all told, aggregating about 175 tons. These samples have all been tested in the boiler plant. Of the coals thus far received twelve have been sufficiently impure to require washing. These twelve have been washed and the washed material tested in the boiler plant.

The gas producing work is not so far advanced, owing to the very late arrival of some of the apparatus, but is now under way (November 1), and will probably be completed before the beginning of the new season.

The work thus done virtually completes the survey of the eastern section, with the one exception of the properties controlled by the Dominion Coal Company, which company did not feel prepared to furnish material for the tests. It is expected to be able to cover the western coal fields next season and also any additional eastern coals which it may be worth examining. It is also hoped that a series of coals from the Dominion collieries may be submitted in order to complete the survey of the country.

In addition to the work above outlined several preliminary samples of western coals have been procured, including lignite from Saskatchewan and anthracite and bituminous coal from Alberta. These samples are now being used in connexion with the development of a producer for dealing with fuels of this character.

In all, counting duplicate runs, there have been completed to date, fourteen washing tests, thirty boiler tests and a very large number of chemical analyses. In addition to this regular work there have been numerous experimental operations for the purpose of adjusting and testing apparatus and for arriving at standard methods of high accuracy. Probably at least one-half of all of the work done thus far has been of this character.

It may be noted that with the one exception mentioned above, all colliery managers have offered the Department every facility in taking samples and have given the coal free of charge.

The railway companies have hauled the coal free in all cases and have thus relieved the Department from what would otherwise have been a very serious item of expense.

PALÆONTOLOGY AND ZOOLOGY.

J. F. Whiteaves.

In the departments of Palæontology and Zoology, Dr. Whiteaves reports as follows :—

PALÆONTOLOGY.

'Illustrations of the Fossil Fishes of the Devonian rocks of Canada, Part III., Supplementary.' At the last meeting of the Royal Society of Canada, held at Ottawa in May, 1907, a paper with this title was presented, which has since been printed in its Transactions. All three parts of this paper are devoted to the description and illustration of the remarkable fish faunæ of the Upper Devonian rocks at Scaumenac bay, Que., and of the Lower Devonian rocks at Campbellton, N.B.

The first and second parts, published in the Transactions of the same society for 1886 and 1888, consist of descriptions, with figures, of seven species of fossil fishes from Scaumenac bay (including an extended diagnosis of the then new genus *Eusthenopteron*), and of four species from Campbellton. These descriptions and figures were based exclusively upon collections made by officers of the Survey in 1880-83. Since 1887, large additional collections of the fossil fishes from these two localities have been made by Mr. Jex, for Mr. R. F. Damon, of Weymouth, England (in 1888-92); by Professor W. Patten, of Dartmouth College, Hanover, N.H. (in 1901-02); by Mr. Louis Hussakof, of the American Museum of Natural History, New York City, and by Mr. L. M. Lambe, of this Survey (in 1905). Most of the specimens collected by Mr. Jex have been acquired for the Edinburgh Museum, or for the Geological Department of the British Museum. The specimens now in Edinburgh have been reported on and described by Dr. R. H. Traquair, and those now in the British Museum by Dr. A. Smith Woodward.

The third and concluding part of the 'Illustrations,' which was commenced in 1906, is a synopsis of the latest information about the fossil fishes from Scaumenac bay and Campbellton. It consists of a revised list, with references, of the twenty-two species now known to occur at these localities, with a copy of the original description of each of the genera and species described by Traquair or Smith Woodward, with supplementary notes on some of the species previously described by the writer.

Two palæontological papers have been contributed to the *Ottawa Naturalist* for February and August, 1907. The first of these is entitled 'Notes on the skeleton of a White Whale or Beluga recently discovered in Pleistocene deposits at Pakenham, Ont.' It gives a somewhat more detailed account of this discovery than that in the Summary Report of this Survey for 1906. The second is entitled 'Description of a Canadian species of *Peltoceras*.' The specimen upon which it is based was collected in the Fernie shales at Rocky Mountains park, Alberta, by Mr. D. B. Dowling in 1906. The discovery of an Ammonite of this genus, and the previous recognition of a species of *Cardioceras* in these shales would seem to indicate that they are, in part at least, of Jurassic age.

A commencement has been made of a systematic list, with references, of the fossils of the Corniferous limestone of Ontario, for which material, in the way of specimens, has been accumulating for years. A rough draft has been made of that part of the manuscript which refers to the corals proper, the echinodermata, and the polyzoa or bryozoa.

A revised list of fossils from the supposed Utica or Lorraine shales at St. Bruno mountain, Que., has been prepared for publication in Mr. J. A. Dresser's report. This list is based upon identifications of species that were made in 1906.

Small collections of fossils from various localities have been examined and reported upon provisionally, for members of the staff, employees of the Department and others. Among these collections are the following:—

Fossils from five localities on Cormorant lake near the lower Saskatchewan river, collected by Mr. W. McInnes in 1906; and from the Pasquia hills, Saskatchewan, collected by Mr. McInnes in 1907. The former are clearly of Cambro-Silurian and probably of Trenton age; and the latter as clearly of Cretaceous and probably of Niobrara-Benton age.

Fossils from four localities in the Yukon territory, collected by Mr. Cairnes in 1906, as follows:—From Limestone range, east of Whitehorse; a fragment of a Zaphrentoid or Cyathophylloid coral. From three miles west of De Witte; a few specimens of an Athyroid or Terebratuloid shell, and a fragment of another brachiopod. The coral is evidently a Palæozoic species, and the Athyroid or Terebratuloid shell seems to be of Palæozoic or Triassic age. From Union Mines, twelve miles southwest of Robinson; and from Torie mountain, seven miles west of Robinson. The fossils from these two localities are of Cretaceous age, and apparently indicate the existence of rocks of the same geological horizon as the Fort Benton group of Nebraska, Colorado and New Mexico.

From two localities in the Bulkley valley, B.C., collected by W. W. Leach in 1907. Thirty-five fossils from rocks that are evidently of Lower Cretaceous age.

PALÆONTOLOGY AND ZOOLOGY.

As it was decided that the General Index, now going through the press, should contain full reference to all the fossils and zoological specimens mentioned in the sixteen volumes, the writer was requested to read all proof containing any mention of palæontological or zoological matter, and to revise the spelling of the family, generic, and specific names therein. The printing of the Index commenced in May, since which time 600 galleys have been received and read.

ZOOLOGY.

A Bibliography of Canadian Zoology for 1906, exclusive of Entomology, has been prepared for the Transactions of the Royal Society of Canada for 1907, and has since been printed therein.

A paper entitled 'Notes on some Fresh-water shells from Manitoba' has been published in the *Ottawa Naturalist* for March, 1907. The specimens referred to in this paper were collected at two localities by Professor Macoun in 1906.

A list has been made for Mr. McInnes of some fresh-water shells that he collected in 1906; and some recent marine and fresh-water shells from Prince Edward Island have been named for Mr. Charles Ives, of Miscouche. Information about zoological specimens has been sent to various correspondents.

DEPARTMENTAL.

During Dr. Low's absence in the field, in the summer months, and during his illness in February and since the middle of September, the duties of Acting Deputy have been performed by the writer, assisted by Mr. Percy Selwyn.

The following specimens were received in 1907, either from members of the staff or from employees of the Survey, in addition to those already mentioned as having been received from Mr. McInnes and Mr. Leach:—

Ells, Dr. R. W.:

About 250 specimens of fossil fishes from the Albert mines, N.B.

Matthew, Dr. G. F.:

Several collections of fossil plants from the north side of the Bay of Fundy, N.B.

Ami, Dr. H. M.:

Fifty fossils (of presumably Upper Carboniferous age), from West Bay, near Parrsborough, N.S.; and about 100 from the volcanic ash beds near the school-house at McAra brook, Antigonish county, N.S.; 100 fossils from the ferruginous beds of the Stonehouse formation (Silurian) along the Arisaig shore, near the contact with the eruptive mass, on McAra brook, below the mouth of Stonehouse brook; and 200 fossils from the Moydart formation along the Arisaig shore, McAra brook.

Twenty-five fossil plants from the coal-measures near Westville, Pictou county, N.S.; and a collection of fossil plants from the Pictou coal basin, near the Vale, the Marsh mine, the Allan shaft, and other localities near Stellarton.

Fossiliferous cores, &c., from the Macnaughton-Fraser bore-hole, on a branch of the Smelt brook near Trenton, Pictou county, N.S.

About 150 fossils from the Silurian limestones at Dalhousie, N.B.; and 100 from the Lower Devonian rocks at Campbellton, N.B.

About fifty fossils from Kennebecasis island, near St. John, N.B.; 200 from various localities in Nova Scotia and New Brunswick; and fifty specimens of plant and fish remains from the Upper Devonian sandstones at Scaumenac bay, P.Q.

Dowling, D. B.:

Twelve fossils from the Lower Cretaceous or Jurassic rocks at the head of Prairie creek, Athabaska river, Alberta.

Malloch, G. S.:

Eight fossils from near the base of the Upper Banff limestones, second range of Rocky mountains, Canadian Rocky Mountains Park, north of Red Deer river; and two fossils from the Lower Banff shale, third range, south of Clearwater river; all from Alberta.

Spreadborough, W.:

Ninety-four skins of mammals, and 172 of birds, from the west coast of Vancouver island. Clutch, of nine eggs, of the Ringed Pheasant; clutch, of two eggs, of the Western Night Hawk; and single egg of the Valley Quail; all from near Victoria, V.I.

Tufts, H. F.:

One hundred and seventy-one skins of birds from Nova Scotia.

Johnston, W. A.:

A collection of fossils from the Peterborough and Simcoe districts of Ontario, including about fifty specimens of Trenton crinoids and starfishes from the vicinity of Kirkfield, Ont.

O'Sullivan, Owen:

Three specimens of a recent marine sponge *(Phakellia ventilabrum)* from low tide at Cape Churchill, Hudson bay.

Young, C. H.:

Specimens of four species of *Sphærium* and one of *Pisidium* from near Ottawa.

The additions to the palæontological and zoological collections in the Museum during 1907, and from other sources, are as follows:—

By presentation:

(A.—Palæontology.)

Grant, Colonel C. C., Hamilton, Ont.:

Eighteen fossils from the Niagara formation at Hamilton; one fossil from the Niagara shale at Grimsby; and eighteen fossils from the Cambro-Silurian drift at Winona, Ont.

Narraway, J. E.:

Specimen of *Endoceras proteiforme* (?) from the Utica shale at Cummings Bridge, Carleton county, Ont.

Topley, H. N.:

Small *Inoceramus* from forty-five miles southeast of Medicine Hat, Alberta.

Hatin, A. F., Ottawa:

Small fossil beetle from Lebanon, Syria.

— Milleken, Gleichen, Alberta; per H. N. Topley:

Silicified wood from 100 miles north of Gleichen, on the Red Deer river.

— Hutchins, Winnipeg, Man.; per H. N. Topley:

Specimen of *Receptaculites Oweni*, from the Winnipeg limestone, and of *Streptelasma trilobatum*, from Stony Mountain.

(B.—Zoology.)

Weston, T. C., Levis, Que.:

Fossil sponge *(Archæocythus)* from the conglomerate near the street railway sheds at Levis.

Eifrig, Rev. C. W. G., Ottawa:

Posterior portion of cranium of moose (?) with basal portion of antlers, from the bottom of Lake Clear, Sebastopol township, Renfrew county, ten miles south of Eganville, Ont.

Ives, C., Miscouche, P.E.I.:

Eighteen specimens of *Clidiophora Gouldiana*, Dall, from the Miscouche shoals; and eight of *Pisidium Idahoense*, Roper, from a pond at the head of Wilmot river, P.E.I.

Brodie, Dr. W., Toronto:

Specimens of *Sphœrium sulcatum, Anodontoides Ferussaciana,* var. *modesta* (?), and *Unio complanatus,* from Muskoka ; and one specimen of *Pyramidula solitaria* (?), from Moyie, B.C.

By purchase:

Specimen of the large Nova Scotian variety of the Wild Cat (*Lynx rufus,* var. *magnus*).

Black variety of the Chipmunk, from Kingsmere, Que.

Albino Virginian Deer, from North Wakefield, Que.

Two Coyotes, two Rocky Mountain Goats, and one Wolf, from British Columbia.

VERTEBRATE PALÆONTOLOGY.

Lawrence M. Lambe (Vertebrate Palæontologist).

My attention has been given principally, during the past year, to the completion of part IV of Volume III (quarto) of Contributions to Canadian Palæontology. This report on the Vertebrata of the Oligocene deposits of the eastern end of the Cypress hills, Saskatchewan, in and near Bone coulée, is based on the collection made by me in 1904 and on the material of the earlier collections. The report will consist of about one hundred pages of text, illustrated by text figures and seven plates. The manuscript is now ready for the printer, as are also the drawings for the text figures and the plates.

The fauna of the Oligocene deposits of the Cypress hills, made known to us by Professor E. D. Cope's memoir of 1891, has been more than doubled as a result of my study of the collections from Bone coulée. New species, and species previously known but not hitherto recorded from this horizon in Canada, have been added. The majority of these additions have been supplied by the collection of 1904, but a few forms are represented by specimens belonging to the earlier collections from the same locality that apparently were not submitted to Professor Cope for determination. In all over fifty species are described or referred to, belonging to the classes of fishes, reptiles and mammals, the last of these preponderating, the fauna being essentially a land one with the addition of some river species.

These Oligocene beds were evidently deposited by rapidly flowing water from the west. The thick beds of rounded pebbles occurring at the base represent the work of a strong transporting force such as would be supplied by a turbulent stream of considerable size carrying eastward material from the Rocky mountains. The sands show false bedding as a result of varying currents. With the accumulation of material eastward and a consequent reduction of the transporting force, beds of finer material were deposited at a higher level and probably on extensive areas of overflow.

The following papers, of which separates have been distributed by this Department, were published during the year :—

'On a tooth of Ovibos from Pleistocene gravels near Midway, B.C.,' *Ottawa Naturalist,* vol. XXI., with plate.

In this paper an upper molar tooth of a ruminant from Pleistocene gravels on Rock creek about eight miles above its entry into Kettle river, southern British Columbia, is described and figured. The tooth is the right posterior true molar and is referred provisionally to the genus Ovibos. It is compared with the corresponding tooth of *Ovibos moschatus* and *Ovis montana* and references are made to remains of Ovibos previously recorded from Canada.

'On a new Crocodilian genus and species from the Judith River formation of Alberta,' Transactions Royal Society of Canada, third series, vol. I., with five plates.

Certain crocodilian remains including a mandibular ramus, the posterior part of a cranium, part of a maxilla, vertebræ, &c., collected by me from the Judith River (Belly River) formation on Red Deer river, Alberta, are described in detail with explanatory figures, as representing a new genus and species. The name *Leidyosuchus canadensis* is proposed for the genus and species.

Among the characters revealed by the Red Deer river specimens are the following principal ones :—

Mandibular symphysis short and contributed to by the splenial. Alveolar border of mandible undulating. Teeth of unequal size, nearly smooth, with an inner area defined by lateral carinæ, the third lower tooth nearly reaching the size of the enlarged fourth. External mandibular foramen and smaller internal one, present. Orbits confluent with lateral temporal fossae and larger than supratemporal vacuities. Eustachian canals enclosed. Snout, as indicated by the anterior end of a maxilla, short and broad. Fourth lower tooth received into a notch in the maxilla. Vertebræ of the procœlian type. Pits of the sculptured bones of the head and of the scutes, deep and separated by narrow ridges.

These characters indicate a brevirostrate form of Eusuchia, different generically from any hitherto known, and one not readily placed in the present generally accepted classifications of the procœlian crocodilia. It differs entirely from described brevirostrate forms in the entry of the splenial into the formation of the symphysis, a character claimed for the longirostrate forms of the suborder. The dentition of *Leidyosuchus* resembles in some respects that of *Diplocynodon* (Tertiary of Europe and America), especially in the enlargement of the third mandibular tooth. The reception of the fourth lower tooth into a notch in the maxilla is a crocodilian character shared by *Diplocynodon.* The form of the occiput appears to approach closer to that of the crocodiles than the alligators and the size of the supratemporal vacuities is rather crocodilian than otherwise.

As a whole, the characters, brought to light by the specimens on which *Leidyosuchus* is based, place that genus close to those members of the crocodilia having broad, short snouts and procœlian vertebræ. The genus is for the present referred to a group such as would be provided by Lydekker's *Brevirostrate Section* of the crocodilidæ if that section were extended so as to include short-nosed forms in which the splenial enters to a slight extent into the mandibular symphysis.

'Note on the occurrence of a supernumerary tooth in a dog,' *Ottawa Naturalist,* Vol. XXI., with text illustration.

The occurrence of an additional first upper premolar is recorded in the skull of a dog, presumably a collie, found at Tranquille, Kamloops lake, B.C., in 1906. Attention is drawn to the narrow skull and lengthened muzzle in this breed of dog and to its affinity to the wolf in this respect.

No field work was undertaken during the past year, as it was considered desirable to complete work already in hand, more particularly the fourth part of Volume III (quarto) of Contributions to Canadian Palæontology above mentioned.

With a view to enlarging and increasing the usefulness of the present inadequate osteologicial collection, a series of skulls of the small Canadian mammals has been selected from the zoological collection of the Survey, the selection being made by Mr. C. H. Young with the permission of Professor John Macoun. Also a mounted disarticulated skull of *Crocodilus niloticus* has been purchased during the past year. It is hoped in the near future, by additions as occasion permits, to bring together a thoroughly representative collection of the skeletons of all living Canadian vertebrate species to be available for comparison with extinct forms, and for the use of zoologists and advanced students visiting the Department as well as for exhibition to the general public.

Reference was made in my last year's Summary Report, to the remains of plants and insects included in my 1906 collection of fishes from the Tertiary sedimentary deposits of the southern interior of British Columbia. The determination of the insects has been kindly undertaken by Professor Anton Handlirsch, Adjunct Curator of the Royal Imperial Natural History Museum of Vienna, Austria, a well known authority on fossil insects. The collection was sent to him early in the year and a report on it, for publication by this Department, may be expected soon. The report on the plants, by Professor D. P. Penhallow, of McGill University, Montreal, has been received and is now being printed by the Survey in quarto form. This illustrated memoir, based principally on my collection of 1906, includes collections of former years and brings to date our knowledge of the Tertiary flora of southern British Columbia.

NATURAL HISTORY BRANCH.

Prof. John Macoun.

Owing to the approaching completion of the Victoria Museum, our Director thought it advisable that more of the time and attention of my department should be given to the accumulation and arrangement of our natural history material. With this object in view, arrangements were made in the spring to add to our collection and as far as possible make an inventory of what material we had so that additions could be obtained when necessary and a correct knowledge be had of the material in stock.

Early last spring, Mr. Charles H. Young, whose work as a skilful and artistic mounter of insect specimens is well known, began the preparation of cases illustrating the life history of our large butterflies and moths, and during the summer continued the collection of material to be used for this purpose. Under my directions he has re-sorted, arranged and catalogued our large duplicate collection of birds and mammals. These specimens have all been stored in air-tight boxes, and unless for purposes of comparison will not be disturbed until needed for the new Museum. They include 2,302 bird skins and 1,106 skins of mammals. Of the birds, 463 are waterbirds, including ducks, 82 are waders, grouse and pigeon, 114 are hawks and owls, and 1,653 are small birds. There are 439 large mammals and 667 small ones.

My permanent assistant, Mr. J. M. Macoun, remained in the office all summer, as there was much routine work in arrears, but Mr. H. F. Tufts, in Nova Scotia, and Mr. W. Spreadborough, on Vancouver island, were engaged in collecting birds and mammals; Mr. Tufts for a few weeks in the spring and again this fall; Mr. Spreadborough during the greater part of the season. Both of these gentlemen made large collections which include many rare species.

Since the date of my last report my assistant, Mr. J. M. Macoun, and I have been engaged in the routine work of the branch, except during the three months I was engaged in western Ontario and eastern Quebec. The determination and distribution of plant collections has occupied much of our time. During the year 1,464 sheets of botanical specimens were mounted and added to the herbarium; 2,278 sheets of specimens were received, and 1,593 sent in exchange.

Early in May I received instructions from the Director to obtain photographs of all our forest trees and at the same time secure specimens of our native woods for the Victoria Museum. With these ends in view I went to western Ontario, and in the course of a couple of weeks located numerous remnants of the old forest and discovered where I could obtain museum specimens of the timber. With Mr. H. N. Topley as photographer and John H. Marshall as assistant, I left Ottawa on June 19, and was occupied in the western peninsula of Ontario until July 28, when we returned to Ottawa. During this time we obtained about 130 photographs of forest trees under three conditions—single forest trees, single trees grown in the open and stands of individual trees in the forest. The height and diameter of each tree were determined, and many photographs of trees ranging from 100 to 144 feet in height were taken.

The series of photos. is very fine, and when enlarged and hung in the Museum will not only be very effective, but will be a permanent record of our forest trees and the conditions of the forests at the present time. About forty trees, almost exclusively confined to western Ontario, were photographed, and forty-one tree-trunks, mostly of the same species of trees, were obtained. These were cut five feet long and averaged two feet in diameter. These photographs and wood specimens will form the nucleus of the wood collection for the Victoria Museum. Mr. H. N. Topley had to leave for Calgary, so our work for the season came to an end.

As opportunity offers I am working up the seaweeds of our Atlantic coast, and in the summer of 1905 I spent about five weeks collecting at Cap à l'Aigle below Murray Bay, on the north side of the St. Lawrence, with excellent results. My collections showed that it was actually the Arctic current that flowed up the north shore of the St. Lawrence. Many species collected by me were common on the coast of Greenland. After my return to Ottawa from the west this summer I spent a week in the office and then went to Gaspé basin and Percé, Que., to continue my study of seaweeds. Five weeks were profitably spent and an extensive collection was made. A study of the species found there shows that the water in Gaspé basin is comparatively warm, especially on the Englishtown side. Haldimand beach, near Englishtown, is very extensive and for over a mile there is an excellent beach suitable for bathing purposes. The seaweeds here showed that the cold current found in the St. Lawrence does not reach the beach, and this is the cause of its popularity for summer bathing. The writer ventures to prophesy that on the completion of the Gaspé railway a large summer hotel will be built on or near the beach, and this region will become better known as a summer resort, as there is good bathing, fishing in the sea and rivers, and very safe sailing on the well-sheltered basin.

In this connexion it should be mentioned that Dr. Chas. A. Hamilton, of Mahone Bay, N.S., very kindly offered in the spring of 1906 to make a collection of the seaweeds in that vicinity. A very large series was collected, and his specimens not only form an important contribution to our herbarium, but will be of great value in assisting in working out problems relating to the distribution of marine flora and fauna. The specimens collected at Mahone Bay indicate an inflow of warmer water at that point than is general along the Nova Scotia coast.

While at work in western Ontario and in the vicinity of Gaspé basin a thorough study was made of the flora, both phænogamic and cryptogamic, and large collections were made. These have not yet been worked up but, besides many rare species, several undescribed forms were secured and the geographical limits of many others extended.

Six hundred and fifty-nine official letters were written and about the same number were received.

THE LIBRARY.

During the twelve months from December 1, 1906, to November 30, 1907, there were distributed 54,781 publications, comprising reports, parts of reports, bulletins and maps; of these, 41,704 were distributed in Canada, the remainder, 13,077, being sent to foreign countries.

The sale of publications during the past twelve months, including reports and maps, amounted to $367.42.

Publications to the number of 3,362 were received as exchanges or donations, including, besides periodicals and maps. reports and publications of foreign Geological Surveys, and memoirs, transactions and proceedings of learned societies in both hemispheres.

As a result of a circular sent to all on the general mailing list, about 15,000 extra copies of the Department's publications were applied for and distributed.

There are now in the library about 16,450 volumes, besides a large number of pamphlets on various subjects.

The number of letters received in connexion with the library was 3,642, besides 3,455 acknowledgments from exchanges and individuals. The number of letters sent from the library was 3,278.

The library is open from 10 a.m. to 4 p.m., for persons wishing to obtain information in regard to scientific matters.

PUBLISHING DEPARTMENT.

ENGLISH SECTION.

F. J. Nicolas.

The following reports and catalogues have been published since January 1, 1907:—

No. 969. Summary Report for 1906.

971. Mines Section Report for 1905.

Descriptive Catalogue of Minerals and Rocks. By R. A. A. Johnston and Dr. C. A. Young.

899. Part A., Vol. XVI., being the Survey edition of Summary Report for 1904.

902. Report on Brome Mountain, Que. By J. A. Dresser.

942. Report on Peel and Wind Rivers, Yukon. By C. Camsell. } Bound together.
943. Report on Upper Stewart River. By J. Keele. }

949. Cascade Coal-field. By D. B. Dowling.

958. Chemistry and Mineralogy (Annual Report). By G. C. Hoffmann.

911. Annual Report (New Series) Vol. XV., (pp. 1025). Containing the following reports:—

(A) Bell, R.—Summary Report of the Acting Director, for 1902.
(AA) Bell, R.—Summary Report of the Acting Director, for 1903.
(F) Dowling, D. B.—Report on Coal-fields of Souris River.
(S) Ingall, E. D.—Report of Section of Mines, 1902.

952. Annual Report (New Series) Vol. XVI., (pp. 733). Containing the following reports:—

(A) Bell, R.—Summary Report of the Acting Director, for 1904.
(B) Ells, R. W.—Report on Graham Island, B.C.
(C) Keele, J.—Report on Upper Stewart River.
(CC) Camsell, C.—Report on Peel and Wind Rivers.
(G) Dresser, J. A.—Geology and Petrography of Brome Mountain.
(H) Young, G. A.—Geology and Petrography of Yamaska Mountain.
(S) Ingall, E. D.—Report of Mines Section, 1903.

977. Report on the Pembroke Sheet. By R. W. Ells.

979. Report on the Klondike Gravels. By R. G. McConnell.

953. The Barytes Deposits of Lake Ainslie and North Cheticamp, N.S. By H. S. Poole.

PUBLISHING DEPARTMENT.

FRENCH SECTION.

M. Sauvalle.

The following work has been executed during the year:—

Translating part of the 'Cruise of the Neptune,' by A. P. Low (No. 905); editing and publishing (in French) Summary Report of the Geological Survey, 1904; translating and editing Report of Section of Mines, 1904; all aforesaid work having been afterwards transferred to the House of Commons Translating Department, as pertaining to the Sessional Document Service.

Translating and editing the following reports:—

No. 995. Report on Chibougamau Region. By A. P. Low.
975. Report on Copper-bearing Rocks of Eastern Townships. By J. A. Dresser.
984. Report on Mineral Pigments of Canada. By C. W. Willimott.
998. Report on Pembroke Sheet. By R. W. Ells.
965. Report on Nickel and Copper Deposits of Sudbury, Ont. By A. E. Barlow.
1016. Report on Gold Values in Klondike High Level Gravels. By R. G. McConnell.

MAPPING AND ENGRAVING.

C.-O. Senécal.

The following is a statement of the work accomplished under the supervision of the Geographer and Chief Draughtsman during the twelve months which have elapsed since December 1, 1906.

Mr. L. N. Richard compiled, traced for engraving, and prepared the colour copy of a geological map of parts of Nanaimo and New Westminster mining divisions of British Columbia, and drew two small maps and a number of diagrams, supplementary to the above, for zinc-cut reproduction. He computed a large number of latitudes and azimuths from observations taken by several field officers, for use on their maps, and spent some time in plotting field notes, &c. The work of laying down geographical projections for the several maps was mostly carried out by Mr. Richard.

Mr. O. E. Prud'homme traced for engraving the map of Conrad and Whitehorse mining district, Yukon; the plan of Malaga gold district, Nova Scotia, that of Brookfield, Nova Scotia, and a cross-section for Manitoulin Island sheet, Ontario. He compiled new surveys made in the vicinity of Cobalt, Ont., for a new edition of the Nipissing and Lake Timiskaming geological sheets. Nos. 131 and 138, Ontario, and prepared the engraver's copy of the same. He traced for photo-lithographing the map of Split Lake-Churchill route, N.W.T., and prepared, for similar reproduction, the copy for a second edition of the map of principal mineral occurrences in New Brunswick. He also prepared the colour copy of the map of Northwestern Ontario, north of Lake Superior. Much time was spent by Mr. Prud'homme in classifying and cataloguing engraved copper plates and lithographic stones, photographic glass negatives, &c.

During the early part of the year Mr. H. Lefebvre assisted Mr. D. B. Dowling in the compilation of a photo-contour map of the coal fields of Alberta. He traced for engraving the maps of Telkwa and Similkameen mining areas, British Columbia, and prepared the colour copy of the Mineral Map of New Brunswick, 2nd edition. Mr. Lefebvre compiled new surveys of Northwestern Quebec for a second edition of the map of the Basin of Nottaway river. This revised map, which entailed almost as much labour as if entirely reconstructed, is nearly ready for the engraver.

Mr. A. Dickison completed the compilation of the two L. Nipigon geological sheets, Nos. 16 and 17, Northwest Ontario series. He assisted Mr. W. H. Boyd in the compilation of two special topographical and geological maps of Rossland and vicinity, British Columbia, and traced the same for engraving. A general geological map of the southeastern portion of Nova Scotia was also prepared from the original published large scale sheets and traced by him for engraving. This map is being revised by Mr. E. R. Faribault. Mr. Dickison also traced for engraving and prepared the colour copy of the map of part of Northwestern Ontario to accompany Mr. W. H. Collins' report, 1906. Mr Dickison devoted also much time on drawings and specifications of a new model of surveying camera.

Mr. G. G. Aitken compiled the preliminary geological map of the Quebec townships adjoining L. Timiskaming, and traced the same for photo-lithographic reproduction. He prepared the colour copies of the Moose Mountain sheets, Alberta ; traced part of Prospect sheet, No. 69 Nova Scotia, for engraving; prepared title, legends, colour copy, &c., of Map of Coal Areas in Alberta, Saskatchewan and Manitoba, and traced eight diagrams showing the mineral production of Canada for 1906. Mr. Aitken also made corrections and prepared colour work on a map of Templeton district, Quebec. This map was sent back to the geologist for revision. Mr. Aitken has now in hand a photo-lithographic map of Ancient Shore-lines of Eastern Ontario.

Mr. R. B. Yorston was appointed on the temporary staff as draughtsman and reported himself for duty on the 9th of February. He compiled, traced for engraving and prepared colour work of map of Older Copper-bearing Rocks of the Eastern Townships, Que. He drew for photo-lithography the map of Klondike gold-bearing gravels, and traced for engraving the Elmsdale and Prospect sheets, Nos. 66 and 69, of the Nova Scotia geological series. He has now in hand the tracing of the Halifax geological sheet.

Messrs. J. J. McGee, Jr., and J. F. E. Johnston made sundry tracings of railway plans and maps; made pantagraph reductions, blue prints, &c., and attended to the indexing of records, plotting, type-writing and general draughting work passing through the office.

The map work carried out by the several field officers was as follows:—

The map of Klondike gold-bearing gravels, Yukon Territory, on the scale of forty chains to one inch, by Messrs. J. Keele, F. H. Maclaren and F. O'Farrell, under the direction of Mr. R. G. McConnell.

The map of Conrad and Whitehorse mining district, Yukon Territory, on the scale of two miles to an inch, by Mr. D. D. Cairnes.

A map of Whitehorse Copper Belt, Yukon Territory, by Mr. F. H. Maclaren, under direction of Mr. R. G. McConnell.

Two maps of certain mining areas in the vicinity of L. Laberge and Tantalus, Yukon Territory, on the scale of one mile to one inch, by Mr. D. D. Cairnes, assisted by Mr. H. Matheson.

A map of Telkwa River mining region, Skeena district, British Columbia, on the scale of two miles to one inch, by Mr. W. W. Leach.

Two special maps of Rossland, B.C., and vicinity, on the scale of 400 feet and 1,200 feet to one inch, respectively, and progress photographic survey and mapping of the Lardeau sheet, British Columbia, embracing parts of Ainsworth, Lardeau, Trout Lake and Revelstoke mining divisions, on the scale of two miles to one inch, by Mr. W. H. Boyd.

Progress work on the photographic mapping of the coal fields of the Rockies between Red Deer and Clearwater rivers, from Vermilion range eastward, in Alberta, covering an area of about 500 square miles, on the scale of forty chains to one inch, by Mr. G. S. Malloch, under the supervision of Mr. D. B. Dowling.

Compilation of two maps of portions of the Northwest Territories traversed by the proposed Canadian Northern railway, Hudson Bay branch, on the scale of eight miles to one inch, by Messrs. Wm. McInnes and O. O'Sullivan.

A map of a portion of Northwestern Ontario traversed by the National Transcontinental railway, between Nipigon and Sturgeon lakes, on the scale of four miles to one inch, by Mr. W. H. Collins.

Progress mapping of the Simcoe geological sheet, Ontario, on the scale of four miles to one inch, by Mr. W. A. Johnston.

Progress work on map of part of Abitibi district, Quebec, traversed by the National Transcontinental railway, on the scale of four miles to one inch, by Mr. W. H. Wilson.

The compilation of the Kingston and Prince Edward County sheet, the Peterborough sheet and the Eastern sheet of the Dominion map are in the hands of the Geographer of the Department of the Interior.

Progress work on contour map of the City of St. John, N.B., covering an area of about 300 square miles, on the scale of one mile to one inch, by Mr. J. A. Robert, under the direction of Dr. R. W. Ells.

A plan and sections of Brookfield gold district, Nova Scotia, on the scale of 250 feet to one inch, and progress work on sheets Nos. 86, 87, 88, 89, 95 and 96, the first three of which are almost completely compiled on the scale of one mile to one inch, by Mr. E. R. Faribault.

Progress work on compilation of the Nova Scotia geological sheets Nos. 97, 98, 99 and 103 on the scale of one mile to one inch, by Mr. H. F. Tufts, under the direction of Mr. H. Fletcher.

The examination and testing of field instruments and the lists of repairs were attended to by Messrs. D. B. Dowling and W. H. Boyd.

The meetings of the Geographic Board of Canada were regularly attended, and as usual, lists of place-names for our maps were submitted for discussion and approval. Lists of approved names are published in the Annual Report of the Board, and from time to time in the official *Canada Gazette.*

Thirty-three new maps have, during the period covered by this report, been issued to the public (see accompanying list), and fourteen others are at various stages of progress in the hands of the King's Printer.

The total number of specification sheets, memoranda, reports, letters, &c., on subjects relating to mapping and engraving was 153 received and 227 sent.

In closing this statement, I may be allowed to call your attention to the fact that a large quantity of preparatory work for the compilation of maps is now advantageously made by photography. Reductions, enlargements, copies, &c., are done very expeditiously by this method, but the quantity of work increases from year to year, and now that well equipped photographic rooms have been placed at the disposal of the draughtsmen the employment of a professional photographer under my supervision is earnestly recommended.

The following is a list of the maps, plans, diagrams, &c., the editions of which were received from the King's Printer during the past twelve months:—

Catalogue Number.	Title.		Area in square miles.
938	Yukon Territory—Geological and topographical Reconnaissance map of Upper Stewart River region. Scale 8 miles to 1 inch	about	5,600
	Alberta—Geological and Topographical map of Cascade Coal Basin, scale 1 mile to 1 inch:—		
929	Sheet I—Panther river	"	130
931	Sheet II—Cascade river	"	176
933	Sheet III—Canmore	"	176
935	Sheet IV—Wind Mountain	"	176
	Alberta—Topographical map of Cascade Coal Basin, showing coal Areas, scale 1 mile to 1 inch:—		
930	Sheet I—Panther river	"	130
932	Sheet II—Cascade river	"	176
934	Sheet III—Canmore	"	176
936	Sheet IV—Wind mountain	"	176
963	Alberta—Geological and Topographical map of Moose Mountain region of the 'Disturbed Belt'. Scale 2 miles to 1 inch	"	1,400
966	Alberta—Geological and Topographical map of Moose Mountain region of the 'Disturbed Belt', showing Coal Areas, scale 1 mile to 1 inch	"	1,400
964	Ontario—Geological map of parts of the District of Algoma and Thunder Bay, scale 8 miles to 1 inch	"	55,000
770	Ontario—Geological map of parts of Hastings, Haliburton and Peterborough Counties. Scale 2 miles to 1 inch. (Second edition)		2,112
926	Ontario—Map of the Gorge of Niagara River, showing New Discoveries in the Physics of the Falls. Scale 20 chains to 1 inch		
967	Ontario—Recession Lines of Niagara Falls, (Revised edition). Scale 200 feet to 1 inch		
944	Ontario—Preliminary Geological map of Timagami and Rabbit Lakes, District of Nipissing. Scale 1 mile to 1 inch	about	280
775	Ontario—Geological map of parts of Sudbury Mining District (Victoria Mines) Scale 1 mile to 1 inch. (Second edition)		216
820	Ontario—Geological map of parts of Sudbury Mining District (Sudbury). Scale 1 mile to 1 inch. (Second edition)		208
	Ontario—Geological map of parts of Sudbury Mining District (Copper Cliff Mines) (Second edition):—		
824	North Sheet, Scale 400 feet to 1 inch	about	5
825	South Sheet, Scale 400 feet to 1 inch	"	5
864	Geological map of parts of Sudbury Mining District (Elsie and Murray Mines) Scale 400 feet to 1 inch. (Second edition)	"	2
605	Ontario—Manitoulin Island Geological Sheet No. 126. Scale 4 miles to 1 inch	"	1,800
660	Ontario—Pembroke Geological Sheet, No. 122. Scale 4 miles to 1 inch		3,456
976	Quebec—Map of the Older Copper-bearing rocks of the Eastern Townships. Scale 8 miles to 1 inch		
1007	Quebec—Preliminary Geological map of a Group of Townships adjoining Lake Timiskaming. Scale 2 miles to 1 inch	about	75
969	New Brunswick—Map of Principal Mineral occurrences, new edition Scale 16 miles to 1 inch		
927	Nova Scotia—General map of the province showing the location of Gold Districts. Scale 12 miles to 1 inch		
700	Nova Scotia—Lawrencetown Geological map-sheet No. 53. Scale 1 mile to 1 inch.	"	80
807	Nova Scotia—Musquodoboit Harbour Geological Map-sheet, No. 54. Scale 1 mile to 1 inch		216
908	Nova Scotia—Gay River Geological Map-sheet No. 55. Scale 1 mile to 1 inch		216
985	Nova Scotia—Prospect Geological map-sheet, No. 69. Scale 1 mile to 1 inch	about	80
937	Nova Scotia—Plan and section of Leipsigate Gold District, Lunenburg Co. Scale 500 feet to 1 inch		
995	Nova Scotia—Plan and Section of Malaga Gold District, Queens Co. Scale 250 feet to 1 inch		
	Also, 8 diagrams showing the Mineral Production of Canada and a number of sketch maps and diagrams to illustrate various reports.		

ACCOUNTANT AND SECRETARY'S DEPARTMENT.

John Marshall.

During the Session of Parliament, 1906-7, an Act was passed to create a Department of Mines, to consist of two branches, the Mines Branch and the Geological Survey Branch, and in pursuance of the provisions of this Act the Department was placed under the control and management of the Honourable Wm. Templeman, M.P., as Minister of Mines, with Dr. A. P. Low as Deputy Minister, Dr. Eugene Haanel as Director of the Mines Branch, and Mr. John Marshall as chief clerk and accountant. In November Mr. Reginald W. Brock, M.A., was appointed Acting Director of the Geological Survey Branch.

The Dominion of Canada Assay Office, Vancouver, was placed under the control of the Department in May last.

The staff of the Department, including that of the Assay Office, at present employed numbers ninety-three.

During the year the following changes have been made in the permanent staff:—

Dr. G. C. Hoffmann, superannuated.
Dr. A. E. Barlow, resigned.

Appointments—

Mr. Walter H. Boyd to the technical class.
Dr. G. A. Young to the technical class.
Mr. M. F. Connor to the technical class.
Mr. F. H. Maclaren to the technical class.
Mr. R. E. Lyons to the junior second-class.
Mrs. Wilhelmina Sparks to the junior second-class.

Promotions—

Miss B. Urquhart to the junior second-class.
Mr. F. G. Wait to be chemist to the Department *vice* Dr. Hoffmann.

The funds available for the work and expenditure of the Geological Survey Branch during the nine months ended March 31, 1907, were:—

Details.	Grant.	Expenditure.
Civil-list appropriation	$ 52,556 25	
General appropriations	103,300 00	
Civil-list salaries		$ 50,687 50
Explorations and surveys		50,162 87
Experimental borings for gas, oil, &c		5,012 00
Wages of temporary employees		31,009 11
Printing, engraving and lithographing		14,060 89
Books and instruments		9,696 05
Chemicals and apparatus		380 40
Specimens for Museum		4,415 00

Stationery, mapping materials, &c.		3,473 61
Ottawa Exhibition, 1906		94 31
Incidental and other expenses		5,964 18
		$174 955 92
Less—Advanced in 1905-6 on account of 1906-7.	$29,295 75	
Deduct—Unexpended advance credited casual revenue	11 98	
		29 2-3 77
		$145,672 15
Unexpended balance civil-list appropriation		1,868 75
Unexpended balances general appropriations		8,315 35
	$155,856 25	$155,856 25

The correspondence of the Secretarial Department shows a total of 2,085 letters sent, and 2,688 received.

With the exception of reports by Mr. R. G. McConnell and Mr. Hugh Fletcher, whose results will be published as separates, as quickly as possible, the above Summary Reports cover the work of this Branch during the year November 30, 1906, to November 30, 1907.

I have the honour to be, sir,

Your obedient servant,

R. W. BROCK,

Acting Director.

Ottawa, December, 1907.

INDEX.

SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE FISCAL YEAR

1907-8

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1908

To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G.C.M.G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII., Chapter 29, section 18, the Summary Report of the work done by the Mines Branch during the fiscal year ending March 31, 1908.

W. TEMPLEMAN,
Minister of Mines.

Hon. WM. TEMPLEMAN,
Minister of Mines.
Ottawa.

SIR,—I have the honour to submit herewith, the Director's Summary Report of the work done by the Mines Branch during the fiscal year ending March 31, 1908.

I am, sir, your obedient servant,

J. F. WHITEAVES,
Acting Deputy Minister.

CONTENTS.

APPENDIX.

SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES

FOR THE FISCAL YEAR 1907-8

J. F. Whiteaves, Esq., LL.D., F.R.S.C., &c.,
Acting Deputy Minister,
Department of Mines.

Sir,—I have the honour to submit the Summary Report of the Mines Branch, of the Department of Mines, for the fiscal year ending March 31, 1908.

The Geology and Mines Act, section 18, provides that, 'the Directors of the branches shall, as soon as may be after the close of each calendar year, make summary reports of the proceedings and work of their respective branches for the year.' The reasons for submitting the report of the Mines Branch for the fiscal year are as follows: (1) a number of the officers engaged in the field did not return to the office until after the close of the calendar year; (2) the report of the Assay Office—which includes the disbursements made in the purchase of gold bullion, and maintenance of the office—can not be made out until all the facts relating to the conduct of the Assay Office for the fiscal year are in my possession.

TRANSFER OF THE MINES BRANCH OF THE DEPARTMENT OF THE INTERIOR TO THE DEPARTMENT OF MINES—AND PARTIAL ORGANIZATION THEREOF.

By an Order in Council dated May 15, 1907, the Mines Branch was transferred from the Department of the Interior to the Department of Mines; together with the following persons employed in connexion with the said Branch:—

Permanent Staff—

Haanel, Eugene—Superintendent of Mines
Nyström, Erik—Mining Engineer.

Temporary Staff—

Lindeman, Einar—Mining Engineer.
Haanel, B. F.—Mining Engineer.
Leverin, Harold A.—Chemist.
Purcell, A. F.—Messenger.
Orme, Miss J.—Stenographer and Typist.
Roger, Harold—Laboratory Assistant.

By an Order in Council dated May 28, 1907, I received my appointment as Director of the Mines Branch, to date from May 3, 1907.

By an Order in Council dated June 19, 1907, Mr. John McLeish, Mrs. W. Sparks, and Miss G. C. MacGregor—then employed in the statistical office of the Geological Survey Branch—were assigned to the Mines Branch.

On November 29, 1907, the chemistry section of the Department of Mines—as well as the following technical officers—were transferred by an Order in Council, from the Geological Survey, to the Mines Branch: Messrs. Theophile Denis, F. G. Wait, M. F. Connor, and W. W. Leach.

FIELD WORK.

IRON ORE DEPOSITS.

During the past year, iron ore deposits in certain districts have been investigated, and the results are given in the following Monograph, and Reports:—

In Preparation—

Monograph on Chrome Iron Ore Deposits of Eastern Townships—by Fritz Cirkel, M.E.

Report on the Iron Ore Deposits of Western Ontario—By F. Hille, M.E.

In the Press—

Report on Iron Ore Deposits of Nova Scotia, (Part I.)—by Dr. J. E. Woodman.

Nearly Ready for the Press—

Report on the Iron Ore Dėposits along the Ottawa (Quebec side) and Gatineau rivers—by Fritz Cirkel, M.E.

Investigations in British Columbia.

The high prices of pig iron, and other merchantable irons, in British Columbia, due to the long hauls necessary to convey these materials from the centres of production, rendered it desirable in the interest of the Province, to furnish such information regarding the iron ore deposits; coking-coal deposits, and fluxes on the Pacific coast —both as to extent and quality—as will encourage the investment of capital for the exploitation of these resources.

Hitherto, no serious investigations as to the probable tonnage, or average quality of the ore, in any of the local deposits, had been made; but judging from the reports of the provincial government, some of the properties on the coast of Vancouver Island, and other islands in the vicinity, seemed worthy of special attention.

Mr. Einar Lindeman—member of the staff of the Mines Branch—was therefore instructed to proceed to British Columbia, and make an investigation of such iron ore deposits on Vancouver Island as are favourably situated in regard to communication; and then to make a more detailed examination of two or more of the most promising, commercially. In the event of these deposits proving to be magnetite, and the terrane found to be suitable, Mr. Lindeman was instructed to make a magnetometric survey of the same. If this ,and further investigations, furnish evidence of the existence on the coast of extensive iron ore deposits, in comparatively close proximity to an assured supply of fluxes, and of coal suitable for the manufacture of metallurgical coke; all capable of economic transportation to industrial centres, then, invaluable information will have been furnished to prospective investors who are interested in the establishing of an Iron Industry in British Columbia.

Mr. Lindeman's report shows that, as regards the ore supply, the deposits on Texada island, at Head bay, Klaanch river, and Quinsam river on Vancouver Island, are of sufficient magnitude to furnish ore to a blast furnace for a number of years. The coal output of the collieries on Vancouver Island, for 1907, is estimated at 1,325,000 tons, with coke production of about 17,000 tons. The coke contains from 15 per cent to 16 per cent of ash; but by a more careful separation of the shale, the ash could be reduced to about 12 per cent. The limestone deposits are of great extent, and unusual purity, hence provide an inexhaustible supply of excellent fluxing material.

The deposits of iron ore, coal, and limestone, being adjacent to the coast, are favourably situated for transportation; and since navigation is open all the year round shipment can be made direct to a furnace located anywhere on the coast line. As regards material, and transportation, therefore, the conditions for the establishment of an Iron Industry on the Pacific coast are favourable. The only drawback is that, labour charges are higher in British Columbia than in the other provinces of the Dominion. Hence, seeing that the market in British Columbia for manufactured iron will for years be a limited quantity, and the United States import duty of $4 per ton on pig iron will render exportation to that country doubtful, it may be necessary to find a market for the surplus product elsewhere.

Iron Mine on the Nipisiguit river, near Bathurst, N.B.

This iron ore deposit, situated fifteen miles from Bathurst, N.B., has been investigated by Mr. Einar Lindeman—who made a magnetic survey of it. The results of this investigation furnish a demonstration of the great utility of magnetometric surveys of magnetite deposits; inasmuch as it has been discovered thereby, that the commercial value of the property does not consist in the deposits he had been instructed to investigate; but more particularly in a large deposit on the other side of Austin brook; discovered during the progress of the magnetic survey of group No. 1, described in the Summary Report of the Superintendent of Mines, 1906-07. It is the discovery of the extent of this deposit that has given the real value to the property. Had the survey been limited to the deposits already known, it is not likely that these would have been considered of sufficient importance for exploitation. The proving of the property was effected by boring; the location of the bore-holes having been determined by Mr. Lindeman from indications of the magnetometric survey.

The property has now been sold to a wealthy and enterprising syndicate; and operations will be commenced at once.

Iron Ore Property near Kinnears Mills, Megantic County, Que.

Upon receiving an appeal from the new owner of the above-mentioned iron ore property, Mr. B. F. Haanel was instructed to inspect the boring operations then in progress, with a view of ascertaining if the work was being done in accordance with his official recommendation made in June, 1905. His report shows that, the methods being employed were altogether inadequate to form a rational opinion as to the value of the property.

Examination of Reported Occurrences of Iron Ore at Penetanguishene, Ont.

In compliance with instructions from the Honourable Minister of Mines—who had received a petition signed by many of the prominent citizens of Penetanguishene —Mr. B. F. Haanel was sent to make an examination of the alleged occurrences of iron ore deposits in and about Penetanguishene, Simcoe county, Ont., and if deemed necessary, to undertake a magnetometric survey of the same. The investigation was conducted in September, and the report in the appendix shows that, in no instance, was there any indication of a disturbance of the earth's magnetic field, occasioned by a magnetic ore deposit; hence precluded the making of a magnetic survey. The investigator, moreover, is of opinion that, the mound of bog ore discovered, originated as a deposit from a nearby spring—dried up long ago: a reasonable deduction, since another spring some miles away, is still actively depositing iron oxide, in the form of a cone shaped mound similar to the one in question; while the reddish discoloration to be seen on stream banks, and by the roadsides everywhere, is manifestly due to the minute particles of iron oxide carried in the drainage waters from the ferruginous Potsdam sandstone in the terraced beaches in the neighbourhood. The general conclusion being that, at Penetanguishene and immediate vicinity, there are no iron ore deposits of economic importance.

THE PEAT INDUSTRY.

The following petition—signed by a large number of influential residents in different sections of the Dominion, asking for a thorough investigation of the peat deposits of the country, by the Mines Branch—was addressed to the Honourable Frank Oliver, Minister of the Interior, and afterwards transferred for action to the Honourable W. Templeman, Minister of Mines.

(Petition.)

June 12, 1906.

The Honourable Frank Oliver,
Minister of the Interior,
Ottawa.

Sir,—In view of the valuable practical work that is being done by the Mines Branch of your Department, in making known the economic possibilities of many of the natural resources of the country, we, the undersigned residents of various sections of the Dominion interested in the development of our fuel resources, would respectfully direct your attention to the important field of investigation afforded by the extensive peat deposits of Canada, and would strongly urge that this subject be made a matter of early and special inquiry by your Department.

Our imports of coal and coke aggregate about $20,000,000 per annum. Not only are they increasing in quantity, but prices are advancing also, thus constituting an enormous and growing drain on the wealth of the country. To retain a portion of this money at home for the employment of our own people, as well as to lessen our dependence upon a foreign country, should, we submit, be regarded as an object of the greatest national importance.

Our fuel supply, to so great an extent, being derived from outside sources, is subject to be seriously interfered with, or even entirely cut off at any time by labour conditions, combinations of capital, or political exigencies, and other causes wholly beyond our control. This is a vital weakness of our industrial and transportation systems, especially in Ontario and Quebec, which are without coal measures.

Apart from this, the growing cost of the domestic fuel supply is becoming yearly a more serious problem to a large portion of the community in these provinces. These facts, together with the rapidly decreasing quantities, and increasing cost of wood, render the early investigation of other possible sources of fuel supply imperative.

Several European governments, recognizing the importance of this matter, have for some time past assisted in the development of the peat industry, with the result that a considerable portion of the fuel supply for domestic and industrial purposes in those countries is now derived from this source. Russia alone produces about 4,000,000 tons of peat fuel per annum; while, under the policy above referred to, Sweden, Holland and Germany have also become large producers. Conditions in Canada are in many ways identical with those in Sweden, and there appears to be no satisfactory reason why the success of that country should not be equally attained by Canada.

It is a matter of common knowledge that large deposits of peat exist at many accessible points in Canada, and a number of efforts have been made by private capital to turn these to account. The results of these efforts have been more or less unsatisfactory in the past, owing in some cases to faulty methods of working, in others to lack of experience of the operators, defective knowledge of the difficulties to be overcome, or want of the necessary capital to cope with these successfully.

We, therefore, believe it would be in the public interest that the Mines Branch of your Department be, at an early date, instructed to make a thorough investigation, with a view to obtaining such reliable information as to situation, extent, capability of drainage, and best methods of working available bogs; together with the quality, character, calorific value, &c., of the peat contained in them, as may aid in the intelligent development of this valuable resource, and we will be glad to place at the disposal of the Department any facts in our possession, or to take any action in our power which may be conducive to this result.

We have the honour to be, sir,

Respectfully yours,

(Signatures.)

INVESTIGATION ORDERED.

In view of this petition, dated May 6, 1907, and in consideration of the recent improvements made in gas producers and gas engines, which has opened up a new field for the utilization of peat and lignite for power purposes, I recommended in a memorandum dated May 6, 1907, that Mr. Erik Nyström—an engineer on the staff of the Mines Branch—be appointed to investigate the Peat Industry in Europe; and that on his return he act as Government expert on the subject of peat and lignite; to give advice to prospective manufacturers of peat fuel, and to assist them in the making of plans for their plants, and for the drainage of their bogs; also to give effect to the petition presented, by commencing an investigation of the more easily accessible peat bogs; to determine and map their extent; ascertain their depth, and best methods of draining, and operating, together with the quantity, character, and calorific value of the peat contained therein.

The following were the instructions given to Mr. Nyström regarding the investigation of the Peat Industry in Europe:—

OTTAWA, May 14, 1907.

SIR,—You are instructed to proceed at the earliest moment to Sweden, Norway, Finland, Denmark, Germany, Holland and Ireland, for the purpose of studying and reporting upon the peat industry in these countries. It will be your duty to familiarize yourself with the methods, processes. and machinery employed in the commercial production of fuel from peat, and lignite; and such other exploitations of peat bogs as lead to commercial products.

This examination is undertaken in the interest of the peat industry of Canada. and it will, therefore, be your duty also to ascertain all facts relating to costs of production; to procure photographs, drawings and plans of machinery, and apparatus used; and obtain information regarding patents issued to the different inventors of processes and machinery, the countries where they have been issued and full particulars thereof.

You are further instructed to visit the peat laboratories of such countries as have established them, familiarize yourself with the methods employed for determining the value and class of peat, and report upon these methods and the apparatus, equipment and arrangement of these laboratories.

(Signed) EUGENE HAANEL,
Superintendent of Mines.

PRODUCTION OF NITRATES FROM PEAT.

In connexion with the utilization of peat bogs, some most interesting experiments have been conducted in France, by Messrs. Müntz and Lainé, on the use of peat in the production of nitrates on an industrial scale, and the results of these researches have been published in a bulletin presented before the French 'Académie des Sciences.'

Owing to the approaching exhaustion of the famous Chilean nitrate beds, the production of this material in large quantities, at low cost, is becoming a very important question. The uses of nitrates are very varied, the most important ones being their application to agriculture, and their entering to a large extent into the manufacture of explosives and war ammunition.

After long and careful experimentation, the authors of the bulletin have presented results which promise to open a new era in the production of nitrates. They conclude that, by passing weak solutions of ammonium sulphate over peat beds specially prepared to set up an intensified action of nitrification, the yield of nitrates is one thousand times greater than by the old methods of nitre-beds, in which nitrification was always regarded as a slow and tedious process.

So interesting have these results appeared, that a somewhat extensive abstract of the bulletin has been given farther on in the report. It will be seen that under certain conditions, one acre of peat bog may be made to produce 300 to 350 tons of nitrate of sodium.

Moreover, I have entered into correspondence with the authors of the bulletin. and with other scientists who are carrying on similar research work, with the view of studying the applicability of such process to the exploitation of our Canadian peat bogs.

In considering the utilization of peat for the production of nitrogenous compounds, the fact has not been overlooked that, sulphate of ammonia is a by-product of coke ovens and gas producers using peat and soft coal, and that from this source it is comparatively inexpensive.

The commercial importance of an extensive nitrates industry in Canada, may be inferred from the following reliable Montreal press announcement on May 26, 1908:—

"Remarkable Cargo from Chili to the St. Lawrence—6,400 tons Nitrate of Soda to be transhipped here for Chicago.

Something new in cargoes for the St. Lawrence route has been secured by P. Warwick Ferns, being a consignment of nitrate of soda, and which is due to arrive in the port of Montreal about the middle of June.

The nitrate of soda is a Chilian product, and is used extensively in the manufacture of explosives and fertilizers. There is a large business carried on between Chili and the United States in this material, and hitherto it has been shipped directly to American ports, going to New Orleans, Philadelphia and Baltimore, and from these places being transhipped to points of manufacture.

Not a single cargo of nitrate of soda has ever been conveyed to a Canadian port, the present venture being in the nature of an experiment, which, if it succeeds, will mean that the St. Lawrence route will capture a considerable share of a lucrative trade.

It had been the custom to ship to the United States ports mentioned, than tranship by rail. The first cargo to come to Montreal will be transhipped by lake carriers to Chicago, Marquette and Aston, the particular advantage being that by an all-water haul and one change, a lower rate can be quoted as against the higher rail haulage charges.

SS. *Taurus* will be the vessel to bring the cargo to Montreal. She will sail from Iquique and proceed directly. She is chartered to carry 64,000 bags of the nitrate: a dead weight of 6,400 tons. The cargo is for the E. I. Du Pont de Nemours Powder Company, a firm which annually handles 350,000 tons of the material.

To reship the cargo of the *Taurus*, four lake boats will be required.

The advantage suggested by the use of the St. Lawrence route is that the steaming distance from Iquique to Montreal is but little different from that between the Chilian port and New Orleans. To reach the latter place it is necessary to swing through the Carribean sea, and then enter the Gulf of Mexico, the two distances about equalizing, while from the Canadian port there is the additional advantage of the St. Lawrence canals inland."

That one Chicago firm alone, should use 350,000 tons of nitrate of sodium, yearly, is evidence of the magnitude of this trade in North America: and the advantages to be gained by the early establishment in Canada of modern plants for the utilization of the immense peat resources of the country, in the manufacture of nitrates.

Peat and Lignite Fuelss Investigation of Gas Producer Systems.

The rapidly vanishing deposits of anthracite coal, as well as the limited deposits of bituminous coal in sight in the United States, and the consequent necessity of an economic supply of fuel for commercial purposes in central Canada has called for an immediate inquiry as to the best substitutes for coal fields. Ontario, having immense resources of peat, it has been deemed advisable to thoroughly investigate the best means of economically using this material for low grade fuel. With this object in view, it has been decided to install in Ottawa an experimental, fuel testing plant, to be operated and conducted by the Mines Branch. And in order to make this new testing station as economically perfect as possible, it was decided to undertake a survey of existing systems To this end Mr. B. F. Haanel was instructed to make an itinerary in the United States, which he did in the autumn: inspecting gas engine, and gas producer plants of repute in New York, Chicago, &c. The valuable, practical data gathered, is found in his report, which appears in the appendix.

ELECTRIC SMELTING.

The great interest taken at the present time in Europe, on the subject of electric smelting, is manifested not alone by the appointment during last summer of two commissions—one by Austria-Hungary, and the other by the Norwegian government, to investigate the progress which has been made in the application of the electro-thermic process to the smelting of iron ores, and the making of steel—but by the extensive experiments in progress in Sweden, and by the very large number of patents which are being taken out for different designs of electric furnaces. In this connexion it may be well to point out that, in but a few cases have these inventions reached even the experimental stage; and it must be insisted on, that no electric process—unless it has been tried by competent parties, and confirmed by facts and figures given regarding output and energy consumed—is deserving of confidence by the public. Astounding claims are frequently made by inventors for the efficiency of their processes, and furnaces.

The real progress made in electric smelting is confined at present to the application of the electro-thermic process in the production of high class steels; the increase in the capacity of the Heroult furnace, and the increase of the power factor and capacity of the Kjellin furnace. In consequence of which, the electric process is gradually displacing the crucible process in the manufacture of high grade steels, and the different alloy steels which have in recent years come into use.

THE LASH STEEL PROCESS.

Of the lately invented systems for making steel, the Lash Process, which is being tried at Niagara Falls, deserves to be specially mentioned. The inventors give the following account of the process:—

The Lash Steel Process.—The Canadian Lash Steel Process Company, Limited.—The Electric Furnace.

In the numerous experiments that have been made with the object of producing steel direct from iron ore, one of the most serious problems was that of heating the furnace charge to the necessary temperature. In the blast furnace this is readily accomplished by mixing with the ore an excess of carbon so that a part acts as reducing agent and a part as fuel, which gives the necessary heat by combustion in the blast. It is possible to make a mixture of ore and carbon where the latter is only present in the proportions necessary for reduction, to place this mixture in a suitable container, and then to heat the latter by means of the combustion of fuel so as to obtain an iron having the desired percentage of carbon; but such a process is not commercially feasible. In order to produce iron from the ore in a commercial manner it appears to be necessary to generate the heat in the charge itself.

The production of electric energy at a relatively low price, and the consequent developments in the design of electric furnace, led to the hope that the problem of the direct production of steel might be solved. Theoretically, it should be possible to place in an electric furnace a mixture of ore with only that amount of carbon necessary for reducing, and for the proper carbon content in the metal to turn out the desired grade of steel. Experiment, however, has shown that this is not commercially feasible because of technical difficulties which quickly appear when the attempt is made.

Successful experiments with the 'Lash Process' in the case of the open-hearth furnace, on a commercial scale, have indicated the possibility of its application to an electric furnace process.

In this process finely divided ore is intimately mixed with carbon, a certain quantity of finely divided carboniferous iron, such as cast iron borings, or granulated pig iron, sawdust and fluxes suitable for the ore under treatment. The mixture is then ready for charging, either loose or in briquetted form, and in general it may be said that it must simply be heated to a sufficiently high temperature in order to obtain the steel.

The working of the process can perhaps be best explained by comparison with the open-hearth 'Ore Process,' which consists in first forming a bath of molten pig iron, and then adding thereto a sufficient amount of ore (Iron oxide) to reduce the carbon content of the metal to the desired amount. The oxygen of the ore combines with a certain amount of the carbon in the pig iron, forming carbon monoxide gas, and the iron of the ore is set free to mix with the bath of molten metal. Following this method we may work up together a mixture of approximately 75 per cent pig iron and 25 per cent ore. But, in the Lash Process, these proportions are very different, for instead of treating a large excess of pig iron with a relatively small amount of ore, we can use a large proportion of ore with a smaller proportion of carboniferous iron.

Turning now to a more detailed examination of the Lash Process, a typical mixture has the following percentage composition:—

Iron ore	54
Cast iron borings, or granulated pig iron	27
Sawdust	4
Limestone	4
Coal tar	3
Coke	8
	100

All the constituents of this composition are in a fine state of division intimately mixed, and when heated to a sufficiently high temperature the chemical reaction between the carbonaceous material and the ore proceeds readily, the iron oxide being reduced by the carbon, forming carbon monoxide gas and metallic iron. The function of the sawdust in the mixture is to make it porous, since at an early stage of the heating the sawdust carbonizes and leaves the mass in a porous state, permitting the easy escape of the gases formed during the reaction.

If we imagine the Lash mixture given above, heated to a high temperature, it is easy to see that the reactions that occur are similar to those found in the open-hearth furnace, using the ore process. The cast iron borings correspond to the molten bath of pig iron, and react with the ore, but the latter being in large excess it is necessary to supply a certain amount of free carbon, in the form of coke, to supply sufficient carbon for the complete reduction of ore.

It is perfectly obvious where the great economy of the Lash Process is found, since the proportion of ore to pig iron is very much greater than in the ordinary open-hearth process, where a large amount of pig iron, and a relatively small amount of ore, or a mixture of pig iron and scrap, must be used. But, briefly, the Lash Process is a method whereby a large amount of relatively cheap iron in the form of ore may be used to replace more expensive pig iron or scrap.

Now, in using the Lash mixture in the open-hearth furnace, it is necessary to have a bath of molten metal, for were it to be charged into an empty open-hearth furnace it would not be practicable to heat it to the reacting temperature without losing carbon in the mixture by combustion. If, however, the charge is put into an electric furnace, no difficulty of this kind is met with, since the gas in an electric furnace is neutral, in contradistinction to the oxidizing atmosphere of an open-hearth furnace.

Experiments, using the Lash mixture, have been made in the electric furnace on a small scale, and the results have been very successful. In these experiments no bath of pig iron was used, but the mixture was heated alone in an electric furnace. It was found that the yield of metal amounted to 98 per cent of the metallic content of the mixture. Using electric energy as a source of heat is in general more expensive than heating by fuel, in spite of the fact that the heat generated is used much more efficiently in the electric than in fuel furnaces; but the economy in the electric furnace is found in the saving of pig iron, which must be used in the open-hearth process.

Thus, the average cost of the regular open-hearth furnace for Canada, to produce 100 tons of ingots, is as follows:—

(Charging materials at cost, and pig metal charged hot)—

65 tons pig iron at $15	$ 975 00	95 per cent metallic	61·75 tons.
43·50 " scrap at $16.	696 00	99 " "	43·06 "
2 " lump ore at $5	10 00	60 " "	1·20 "
½ " Ferro at $60	30 00		
		Total contents.	106·00 "
Total cost char ge	$1,711 00		
Credit 2 tons scrapat $16	32 00		
	$1,679 00		
Cost per ton			$16 79
Cost Conversions			4 00
Total cost Ingots per ton			$20 79

If, on the other hand, the electric furnace is used, we would have the following figures:—

181 tons mixture at $5.96	$1,078 76	58 per cent metallic	104·98 tons.
2 " lump ore at $5	10 00	60 " "	1·2 "
0·5 " Ferro at $60	30 00		
		Total contents.	106·18 "
Total cost charge	$ 1,118 76		
Credit 2 tons scrap at $16	32 00		
	$1,086 76		
Cost per ton			$ 10 87
Electric power			3 25
Electroids			0 10
Conversion			2 00
			$16 22

* Cost of materials, Oct. 1907.

The best results in the practice of the United States Steel Corporation, charging hot pig metal and other materials at cost, are as follows:—

Regular Open-hearth Charge.

65 tons molten pig at $12	$ 780 00	95 per cent metallic	61·75 tons.
43·50 " scrap at $16.	696 00	99 " "	43·06 "
2 " lump ore at $5	10 00	60 " "	1·20 "
" Ferro at $60	30 00		
		Total contents.	106·00 "
Total cost charge	$1,516 00		
Credit 2 tons scrap at $16.	32 00		
	$1,484 00		
Cost per ton			$ 14 84
Conversion			2 00
Total cost Ingots per ton			$ 16 84

(Cost of materials, Oct. 1907.)

Now the experimental work carried out in the electric furnace for the reduction of iron ore indicates that the cost of conversion should be as low or less than $3.95 per ton, and arrangements have, therefore, been made to test various electric furnaces, with the object of finding out those forms to which the Lash Process is applicable.

Recapitulation.

The electric furnace cannot be used at the present time for the direct production of steel, owing to certain technical difficulties.

But, by applying the Lash Process for the production of steel in the open-hearth furnace, with suitable modifications for the electric furnace, it is believed that the problem can be solved.

Therefore, in all cases where, for whatever reason, the use of the electric furnace rather than fuel furnaces is desirable, steel may be produced directly from the ore in the electric furnace.

Respectfully submitted,

THE CANADIAN LASH STEEL PROCESS CO., LTD.
THE LASH STEEL PROCESS CO.

Mechanical Improvements, and the Utilization of Waste Gases: Swedish Experiments.

Although the experiments made at Sault Ste. Marie, under Government auspices, have settled the metallurgy of the Electric Process, and have demonstrated the important fact that sulphur up to 2 per cent can be almost completely eliminated, the furnace with its interior electrode did not permit either the satisfactory application of labour saving machinery for charging, or the proper collection or utilization of the carbon monoxide evolved.

Experiments have been conducted in Sweden during the last winter, (1907-8). with a view of overcoming these difficulties: the sum of 200,000 kronas being appropriated for the purpose. Reliable information just to hand indicates that, the Electro Metal Co., of Sweden, have—after experimentation with different reduction furnaces —achieved satisfactory results with the latest type of the series of furnaces tried, hence they are now constructing on a larger scale a furnace of 700 h. p.

The above mentioned Company have recently delivered to a firm in Brazil one induction furnace for steel manufacture, of 250-300 h. p., (50 periods) designed for a charge of 1,000 kilos. This Company also builds electrode furnaces for steel making. Of this type, two, having a capacity of 1,000 and 500 kilos., respectively, are at present under construction; and a larger one for 5,000 kilos. charge, will shortly be commenced.

Experiments with Furnace on New Principle, and on a Commercial Scale, at Welland, Ont.

The Electric Metals Co., Limited, who have erected a plant at Welland, Ontario, and are at present engaged in the making of ferros: using for the purpose iron pyrites cinders, are at present building an electric furnace on a new principle, for the smelting of iron ores. The furnace is of 500 h. p. capacity, and is being built at the expense of Dr. Heroult. If successful, larger furnaces will immediately be built. It is the intention of the Company to spare no effort in bringing to a successful issue the construction of a thoroughly commercial iron-ore melting furnace.

The Company own some 40 acres of land south of the town of Welland, with a frontage of over half a mile on the east side of the Welland canal, and within easy communication with the Michigan Central, Grank Trunk, Canadian Pacific, and Wabash railways.

The works are located on the north side of the property: consisting at present of a large steel building, in which are placed the electric furnaces; with sample room for raw material, crushing plant, &c. The transformer room, with tower for the entrance of the high tension current wires, is built against the main building. Other separate buildings consist of stores, offices, and an electrode plant, in which latter, electrodes of excellent quality are being made. The transformer capacity is at present 7,000 h. p. The President,—R. H. Wolff, of New York city—and Vice-President, R. Turnbull, of St. Catharines, Ont., are the agents of Dr. Heroult on this continent. The Company, however, is an independent corporation.

Desulphurization of Raw Material in the Kjellin Furnace.

Dr. A. Schmidt, of Zurich, has made the interesting observation that, the important factor in the desulphurization of the bath in the Kjellin steel furnace, when the ore process is employed, is to be ascribed not to the high temperature of the bath, nor to the nature of the slag, but to the iron oxides added, and to the specific influence of the alternating current: which produces molecular oscillations in the bath, rendering the combination of the oxygen of the added ore, and the sulphur contained in the bath, more active; and that the resulting SO_2 passes off in the form of gas. In the experiments made at Sault Ste. Marie in the smelting of sulphurous ores, I was surprised at the volumes of sulphur dioxide escaping during the operation of slagging. If this explanation offered by Dr. Schmidt of the cause of the desulphurization of the bath is correct, then, as he himself states, a continuous current would not, under like conditions as to bath and addition of iron oxide, be effective in producing desulphurization.

Comparative Merits of Induction Furnaces.

In the appendix will be found an able critique by Mr. A. Grönwall—a Swedish authority on Electro-metallurgy—on the respective types of induction furnaces employed at the present time in the production of steel.

New Electric Furnaces Installed in Canada.

An Induction furnace—Snyder's patent—has been erected at Nelson, B.C., for the production of lead bullion and commercial spelter—in one operation. The electrical energy for operating this plant is being delivered from Bonnington Falls, at a specially low rate for the first year.

MINING AND METALLURGICAL INDUSTRY OF CANADA.

In accordance with the provisions of Section 6 (a) the Geology and Mines Act: 'to collect and publish full statistics of the mineral production, and of the mining and metallurgical industries of Canada,' a first attempt has been made to gather material for such report.

The following are the persons who have been appointed in connexion with this work:—

Yukon Territory:	D. D. Cairnes.
British Columbia, Alberta, Saskatchewan and Manitoba:	R. R. Hedley.
Ontario:	Fritz Cirkel and J. J. Bell

Quebec:	J. W. Bell.
Nova Scotia and New Brunswick:	W. F. Jennison, of Jennison & Dahl.

Instructions were given, to report only upon producing mines, or mines having expectation of early shipment, and upon metallurgical plants in active operation; the information obtained, and submitted, to be the result of personal visitation to the respective mines and plants.

In gathering the necessary material for this report, many difficulties were encountered in getting satisfactory, and complete data about certain of the industries —as regards processes, prices, etc.; while in a number of instances it was practically impossible to obtain from the local officials, complete information as to the personnel of the various industrial corporations; since the head offices—a number of which are in other countries—alone possess the records; and from some of these the facts could not be elicited, even by correspondence.

The rapid progress being made in the development of the mining and metallurgical industries, together with the constantly changing conditions as regards labour. market, and prices, will necessitate the publication of annual supplementary statements, in order to bring the original report up-to-date; and will subsequently call for the issuance of a complete new report, embodying these important changes, and additional technical information.

YUKON TERRITORY.

(D. D. Cairnes.)

About two months were spent by Mr. D. D. Cairnes, during the latter part of last season, (1907) in the Yukon Territory: gathering information as to the extent and condition of the mining and metallurgical industries therein.

In the Dawson district, Mr. Cairnes had to depend to a considerable extent on mine-managers, superintendents, &c., for the necessary information as to company organization, details of installation and equipment, number of men employed, costs of operation, etc.; but he says that in all cases ,and in every possible way ,assistance was readily given.

All the properties reported upon—except a few in outlying districts—were visited personally, hence the facts given were obtained by actual observation on the spot; supplemented by carefully sifted information gathered from all available sources. The data collected, indicates the conditions in the entire Yukon Territory, with the exception of the copper deposits at Whitehorse.

The following is a short account of the present state of the Mineral Industry in the districts reported upon.

Only two of the silver-gold properties in the Windy Arm district were being operated. One of these is likely to be a producer in the near future. It is expected that work on others will be resumed during the coming season. The quartz properties on Williams creek, Livingstone creek, and others in the vicinity of Dawson, although promising, are all, as yet, strictly in the prospect stage.

Large areas of lignite, and bituminous coal, have been found in different parts of the Yukon; accessible either by boat, or rail. Last season, only two mines were in operation, producing respectively about 9,000 and 8,000 tons.

By far the greater part of the placer gold of the Yukon comes from the Klondike district. A very small amount is derived from the Kluane district. The remainder is from Livingstone creek—a tributary of the Big Solomon river—which, for several years has had an increasing production; the output last season amounting to $100,000—approximately. Other undeveloped creeks in the vicinity promise to be equally productive.

The gold output of the Klondike district last season (1907) was comparatively low—for a number of reasons. The richest parts of the creeks have been worked over, and most of the gold won by very primitive methods of operation; hence the properties so exploited have by no means been exhausted. The time has arrived, however, for the introduction of more modern, up-to-date, and systematic methods of working and management. By so doing, the remaining gold from the still rich, vast areas of gravels in the northern Yukon, may be recovered.

For the reason assigned, a great portion of the Dawson district is now in the intermediate stage: where it does not pay to work the claims by former methods; and where the owners, in many cases, are undecided as to which method to adopt. The Yukon Gold Company (The Guggenheims) now own practically all the more important gravels on Bonanza, Eldorado, and Hunker creeks, and their tributaries. To work their vast holdings economically, the above-mentioned Company are spending several millions of dollars on modern installations: including dredges, newly designed electrically driven mechanical elevators, construction of ditches and flumes, building of dams, &c. While these improvements are being made, very little gold is actually being won. Moreover, last season was unusually dry; so that on the properties in a workable condition—especially those with hydraulic installations—water for operating purposes was obtainable for only a short period.

On some of the creeks tributary to the Indian river, there was, during the last season, considerable renewed activity; due to the staking of virgin portions of the creeks, formerly considered too low grade. These portions—particularly on Dominion creek above Granville, and those near the mouth of Sulphur creek—have been proved to contain gold in paying quantities, when worked by modern methods.

Another striking feature noticed last season was, the staking of new creeks; such as Clear, and Black Hills, the latter being staked from head to mouth. It is believed that the values found are very encouraging.

So that, although the days of the individual placer miner in the Klondike are practically at an end—at least on the older creeks—the country is by no means nearly worked out: and a continued large gold production may be expected for many years to come. When the installations of the Yukon Gold Company are completed, a considerable increase over the last fiscal year's production ($2,820,011.55—computed at $15 per ounce: which is less than its real value) is anticipated. It is true that certain of the older creeks have been practically worked out by the present methods of operation; but newer systems of working are being discovered, and new fields being found. The Stuart river and its tributaries will, judging by last year's prospecting, yield much more than heretofore.

BRITISH COLUMBIA, ALBERTA, SASKATCHEWAN, AND MANITOBA.

(*J. J. Hedley*).

The report of Mr. Hedley shows that, in 1907 there was much activity in the mining and metallurgical industries of the western provinces, until November, when the financial depression caused a serious check to new enterprises; though many of the well established industries weathered the storm, or resumed operations after a short cessation.

It appears that, as in the Yukon Territory, so in British Columbia—particularly at Atlin, and in the Cariboo district—the individual placer industry is being superseded by companies working the low grade areas of gold bearing gravels on a large scale, and with more modern appliances: all having the promise of an increasingly profitable industry. While the new pioneer camps in the north-western interior are said to be very encouraging.

At the coast, the principal industries are the smelting works of the Tyee Copper Company at Ladysmith, which has built up a considerable custom business; and the mines, concentrator, and smelter of the Britannia Syndicate.

In the interior of the Boundary country, economic progress is reported in the cheapening of working costs, in both mining and smelting. In this district, also, the financial depression, together with high prices and wages, caused a stagnation of production, and of trade. Rossland camp has re-established its industries steadily and definitely; although the profit margins are small. The mining of gold-copper ore shows marked development. In the shafts, levels are being opened 2,000 feet below the surface—practically the level of the Columbia river.

At Trail, the smelter—which has been steadily improved as regards equipment and operating facilities—is evidently doing a profitable business in the smelting of not only gold-copper ores from Rossland, and the Boundary; but ores of lead, silver, and gold also. Base bullion from the lead furnace is desilverized and refined at the Electrolytic Refinery nearby, which has a capacity of 80 tons daily. The products of this celebrated refinery are: pig lead of exceptional purity, lead pipe of all sizes, refined silver, gold, and antimony, as well as copper sulphate.

The companies producing silver-lead. are very limited in number:—

Over 1,000 tons	= 7
Between 100 and 1,000 tons	= 18
One car load or more	about 50
Only a few tons	= 20

Many of these properties situated in the Slocan, are in a position to produce a fair tonnage of galena ores, but are not operating; since the market for zinc ore in Canada is limited, while the high tariff makes shipment to the United States practically prohibitory.

The old Blue Bell mine has been developed with such satisfactory results, that a complete modern concentrating plant has been installed. In East Kootenay, the development on the St. Eugene mine has been very extensive; and the concentrating mill has been so effectually improved, that low grade ores in large tonnage are being handled with great economic advantage.

As a result of practical experiments in Vancouver, and elsewhere, an electric smelter is in process of erection at Nelson, in which it is proposed to treat mixed argentiferous lead-zinc ores; with a view of producing lead bullion and commercial spelter in one operation. Electrical energy, for power purposes, will be furnished from Bonnington falls.

In the Crowsnest Pass, bituminous coal field, old mines are being re-equipped, and new ones opened; so that there will soon be an abundant coal supply from that region. In the anthracite field—on the main line through Alberta—coal is not only being mined in greater quantity; but existing mines are being more extensively developed, and the best modern equipment for dressing, is being installed. The briquetting product of the plant at Bankhead, in the Rockies, has created such a demand, that the company has doubled its installation. Owing to the fact that, lignite fields depend largely on cold weather for a market, they were not as active as usual at the end of 1907. The coal fields of Vancouver Island continue at about the same rate of production, though the demand far exceeds the supply. New companies are, however, exploiting promising areas, so that an increasing supply may be anticipated.

Two companies are actively developing coal areas in the Nicola valley: one of which is already producing steam coal of excellent quality. At Princeton, one company is fully equipped for the mining and production of high grade lignite, as soon as the railroad—now within twenty-five miles—reaches the camp.

Cement was being produced at the end of the year by two companies: one situated on Vancouver Island, B.C., and the other at Calgary, Alberta; while a modernly equipped plant has recently been completed at Exshaw near Banff, and another is under erection near Blairmore in the Crowsnest pass.

The brick, and building material industry generally, was very active: the demand in Alberta calling for shipment to long distances. Two sand lime brick industries have been established, one at the coast, another at Regina, Sask., and a third in contemplation at Edmonton, Alta.

ONTARIO.

(*Fritz Cirkel.*)

The report of Mr. Fritz Crickel shows that, the mining and metallurgical industries of Ontario are in a flourishing condition. Of special interest are his statements regarding the iron, steel, and copper industries, and the Cobalt mining camp.

There are now established in Ontario, seven blast furnaces, with a total capacity of 1,300 tons of pig iron per day: representing an increase of 400 tons per day over 1906. This increased output is due to the blowing in of the new furnaces of the Atikokan Iron Works at Port Arthur, and to the enlargement of the plant at Hamilton.

In the operation of these furnaces, it is important to note the preference given to Canadian, over foreign ores. The Atikokan Company use ores from the Atikokon iron range almost entirely; while the Moose Mountain iron mine, having extensive deposits of high grade iron ore, will be in a position to ship to every blast furnace in Ontario in the spring of 1908.

Five works are engaged in the production of iron and steel castings: two of which are manufacturing steel. Two complete steel plants, equipped with six basic, open hearth furnaces, and a number of Bessemer converters, were in active operation in 1907.

An interesting feature in connexion with the various manufactures of iron in the province of Ontario, is the marked increase in the production of malleable cast iron. In a paper read recently before the Institution of Engineers and Ship Builders, Scotland, March 17. 1908. Mr. William Herbert Hatfield points out the largely increased application of malleable cast iron, in the metal trades generally—especially in the United States: and emphasizes the fact that, the maximum tensile stress in this kind of iron is very high: having practically twice the strength of ordinary cast iron; while its malleability and ductility, permits of easy work in the machine shops. Malleable cast iron is made by melting suitable pig iron, either in a reverberatory, or open-hearth furnace, and casting the same into moulds. These castings are then subjected to a process of annealing, in order to effect the requisite malleability. The finished article, if properly manufactured, possesses all the advantages of cast iron, since the low melting point of pig iron allows the most intricate and difficult casting to be made.

Malleable cast iron can be made practically free from blow holes, the composition of it ensuring the perfect exclusion of the gases; which, in steel castings, very often cause much trouble.

In the province of Ontario, eight companies are now engaged in the manufacture of malleable cast iron. Five of the latter produced in 1907, 20,700 tons: their daily combined capacity being 105 tons. The total production of pig iron for the same year was 275,508 tons.

This rising industry seems to promise well for the future, as the ease with which malleable cast iron is manufactured, together with its comparatively high tensile strength, and ideal working qualities in the machine shops, renders it very suitable for the smaller working parts in machinery, where heretofore, steel—manufactured by bessemerizing, or by the open-hearth process—was used.

Developments during the past year in the Cobalt camp, have been largely with a view to opening the mines to proper depth, and preparing stopes to permit of uninterrupted operations during the winter; instead of gophering the rich narrow veins. There are now twenty shipping mines in the camp, and a few others will soon be added to the list. The total production for 1907, is approximately 28,000,000 pounds, having an estimated value of about $6,000,000; but the smelting facilities for Cobalt ores are still inadequate. The only plant which treats Cobalt ores in Ontario, and then, only a certain class of ore, is the reduction plant of the Canadian Copper Company at Copper Cliff. When the old plant at Deloro, Ont., is remodelled, Cobalt ores will be treated there also. The plant of the Montreal Reduction and Refining Company, at Trout lake, near North Bay, is not yet in operation.

The Copper-Nickel Industry of the Sudbury district, continues in a flourishing condition. The smelting works of the Canadian Copper Company, with the addition of the new Bessemer plant now in course of erection, will be the largest of their kind in the world. In the first nine months of 1907, they treated not less than 230,000 tons of copper-nickel ore; or 1,000 tons of ore per day, approximately.

Of special interest is the activity displayed all along the copper bearing formation which follows the line of the Canadian Pacific railway from Victoria Mines to Sault Ste. Marie, and also along the line of the Central Ontario railway.

Quite a number of copper properties have been opened; and although most of them are only prospects, the outlook is so encouraging for the future, that it is deemed advisable to have this district further investigated by a competent engineer. There are already three shipping mines, and quite a number will be added as soon as there are proper smelting facilities.

The erection of copper smelters at Sault Ste. Marie, Ont., is in contemplation, also at Thessalon, Ont., on the 'Soo' branch of the Canadian Pacific railway.

The new oil and gas fields near Tilbury, on the Niagara peninsula, are producing now, more oil from about 250 wells, than the old Petrolia field with its 6,500 wells.

Judging from the report of Mr. Cirkel, this Tilbury field will likely extend towards the south as far as Lake Erie; it is, therefore, very probable that new wells will be established, thus adding considerably to the present production.

A statistical abstract of Mr. Cirkel's report, gives the following interesting figures as to the number of producing companies engaged in the Mining, Metallurgical, and allied industries:—

Iron and steel	13
Copper	5
Copper nickel	2
Iron ores	3
Silver cobalt	24
Gold	5
Natural gas	15
Petroleum, about	300
Salt	12
Cement	18
Potteries and sand	24
Brick and tile factories	280
Miscellaneous mines	20
	721

Mr. Cirkel was assisted by Mr. J. J. Bell of Toronto, who visited and reported on all potteries, brick and tile factories in the province.

Clay Industries.—The investigation of the clay industries in the province of Ontario was commenced by Mr. J. J. Bell, on July 10, 1907. From that date to the 26th of December, Mr. Bell visited all the brickyards and tile factories in the province. Using Toronto as a centre for his various excursions, he visited upwards of 300 brick and tile yards, and all the potteries—with the exception of one very small establishment. Also, six sewer-pipe works; six plants where sand-lime bricks are manufactured, and four where artificial stone is made. In addition to these, Mr. Bell visited a large number of lime works, stone quarries, and cement block and brick works; as well as several salt, cement, and peat works.

In November, Mr. Bell attended the Clay Products Manufacturers' Convention at Ottawa, where he gathered valuable information and data; all of which, together with particulars and descriptions of the respective works and establishments visited, are fully detailed in his report.

QUEBEC.

(*J. W. Bell.*)

The report of Mr. J. W. Bell indicates that, the mining and milling of asbestos is the most important mineral industry in the province, which is confined in the Eastern Townships, to the serpentine areas of a mountain belt extending from the boundary of Vermont to the extreme limit of the Gaspé peninsula. The Thetford, and Black Lake serpentine areas, and a small detached area near East Broughton, are, however, first in importance; since they contain the workable deposits. The greater portion of the crude asbestos produced, is derived from thhe Thetford mines, whilst the output from Black lake and Broughton is chiefly milled product.

Commercial and other conditions in 1907, were very favourable, hence there was a considerably increased production, viz., 90,537 tons—asbestos, 62,018; asbestic, 28,519—and at the same time, an advance in price. Over 6,000 men are engaged in the asbestos industry in the province.

At the present time, only two mines are actively engaged in the production of copper ore, namely, those of the Eustis Mining Company, and the Nicholls Chemical Company: both operating at Capelton, near Sherbrooke. At the same time, much activity is being manifested in the development of promising prospects in the above-mentioned, and other districts. The copper ore production last year amounted to 30,000 tons—approximately: carrying from 1½ per cent to 6 per cent copper, small values in gold and silver, and from 25 per cent to 40 per cent sulphur—which latter is turned to account in the manufacture of sulphuric acid. The copper industry employs 250 men.

Bog iron ore is mined by two companies operating in the St. Lawrence valley, near Three Rivers. About 5,000 tons of high grade, brown hematite ore, containing approximately 51 per cent of metallic iron, was dredged out of the bed of Lac-a-la-Tortue last year. This coke ore—which is deposited yearly—is one of the most remarkable examples of modern iron ore formation. Dredging is undertaken continuously for ten years, during which time some 50,000 tons of coke ore is taken from the lake bottom. The pig iron product of these ore on account of its high tenacity, and non-oxidizing qualities, is used for propellor blades, etc.; while ' the harder grades have been used for over fifty years as the basis of practically all the chilled iron railway car wheels made in Canada; the life of wheels made from this metal, surpassing all the best records of the American railways. The metal is also used for chilled rolls: and for this purpose, is shipped regularly to Pittsburgh, and finds a market also in various engineering establishments on the continent of Europe.' At the end of every decade, the lake is given a rest of from four to five years. The last rest terminated in 1905. The total production of bog ore in 1907, was approximately 22,500 tons, and the industry employed 100 persons.

Progress has been made in the mining of chrome iron ore, which is carried on in the Eastern Townships by four companies. The fiscal returns for 1907-8 show a production of 7,196 tons of this ore, most of which is marketed in the United States, for use in the lining of basic, open-hearth steel furnaces; and, as ferro-chromium from the blast furnace, in the manufacture of railway tires, springs, armour piercing projectiles, etc.

Referring to the mica industry, Mr. Bell points out that, phlogopite, or amber mica, is a variety peculiar to Canada, and in Quebec occurs in the region north of Ottawa. In this industry 275 men are employed, and the production of thumb trimmed and split mica, last year, was 550,000 pounds.

The other metallic, and non-metallic products of the province are: zinc, natural gas, cement, lime, stone, bricks, tiles, etc., all of which are dealt with in Mr. J. W. Bell's report.

NOVA SCOTIA AND NEW BRUNSWICK.

(W. F. Jennison.)

The contribution of Mr. Jennison to the general report on the mining and metallurgical industries of Canada—dealing particularly with conditions in Nova Scotia, and New Brunswick—shows that, the enviable reputation which the Maritime Provinces have long held as mineral producing sections of the Dominion—especially bituminous coal—is being well sustained. The gypsum deposits are said to be, as regards quantity and variety of quality, the most extensive in existence: and are only in the primary stage of development. In addition to these resources, an appreciable commerce is being carried on in the metallic ores of iron, gold, and antimony; also in dolomite, limestone, fluorspar, and other materials used in metallurgical processes, besides clays, building stones, etc. In the manufacture of steel on a large scale and by approved modern methods, Nova Scotia has shown, and is showing, great enterprise.

Coal.—The coal fields of Nova Scotia cover an area of about 725 sq. miles, and are located in four divisions: Cape Breton, Pictou, Inverness, and Cumberland districts. All these fields are practically on the tide water, which gives a transport advantage possessed by no other district on the American continent. The output for the provincial fiscal year ending September 30, 1907, was 5,720,660 tons; upon which a royalty of $650,341.32 was received. This industry gave employment to 11,500 miners alone. The coal mined in Nova Scotia is almost exclusively bituminous, of excellent steaming quality, and mostly coking. In some cases, notably in the northern field of the Cumberland district, the slack is being utilized for the generation of electricity: used for power and lighting purposes in the neighbouring towns.

In New Brunswick, bituminous coal has been mined for over 200 years. The total production in 1907 was: 48,000 tons; the greater part of which—outside domestic consumption—is used by the Intercolonial railway.

Gold.—The gold fields of Nova Scotia have been known since 1860. The report indicates, that at one time this gold field, occupying the Atlantic half of the province, was very popular, a large number of mines, or prospects, having been opened out and worked. The total amount of material crushed from 1862 to 1907 inclusive was 1,915,039 tons; yielding a total output of 887,886 ozs., 11 dwt., 22 grs. Of late there has been a considerable falling off in interest and enterprise, the total output of gold for 1907 was 13,687 ozs., 6 dwt., 20 grs., from 64,657 tons of material crushed. Upon this, the provincial government of Nova Scotia received a Royalty of 2 per cent, on all milled gold, valued at $19 per oz. It should be pointed out, however, that the values indicated do not represent the intrinsic worth of the gold won from the ores by the primitive methods of extraction employed. But as in the far west, so in the east, more up-to-date apparatus, and modern machinery are being installed. And two operating companies are mentioned as being distinctive in this respect, viz., Boston and Richardson of Guysboro, and Micmac of Lunenburg, where the highest economy is being practised. It is safely predicted that, these object lessons in economic production, will give an impetus to the gold mining industry of the province.

Gypsum.—The extensive gypsum deposits of Nova Scotia and New Brunswick have hitherto attracted little attention, although this material—used as plaster—is becoming of increasing importance in the industrial world. The actual extent of the deposits is unknown, but it is safe to say that they cover hundreds of square miles. In many places the outcrops may be traced for miles in length: at some points they show an exposed height of 200 feet. Practically the whole production in crude condition, is exported into the United States. Many years ago the manufacture of gypsum in Nova Scotia was an important industry; at the present time only one firm (The Albert Manufacturing Co., Hillsboro) attempts to supply the market with the manufactured product. The reason for this decline is, that the United States placed a practically prohibitive tariff on manufactured gypsum, letting the raw material go free; hence the mills were forced to close down. At the present time this valuable mineral asset is being exploited almost entirely by American capitalists, who control the output of crude gypsum and give little encouragement for local manufacturing. The commercial value of this mineral may be inferred from its varied use. (1) Alabaster, or satin spar for ornaments. (2) As land 'plaster' for fertilizing. (3) Glass and porcelain. (4) As a disinfectant on account of its absorptive properties. (5) Plastering walls. (6) Moulds for coins, statuary and pottery. (7) Binding broken limbs. (8) In dentistry for mouth impressions. (9) Cornices, mouldings. (10) Finishing plate glass. (11) Alabastine and similar wall washes, etc.

Iron Ores.—The iron ores of Nova Scotia are not confined to any particular horizon; but are found in more or less quantities in fifteen out of the eighteen counties. On only two, however, are operations active, viz., Londonderry, Colchester, and at Torbrook, Annapolis. At the former mine about 125 men are employed producing brown hematite, and carbonate ores, of 48·06 and 17·55 per cent iron contents respectively. At the latter place, the Annapolis Mining Company Limited, own about 5,000 acres of iron ore lands free from government royalty, because the lands were granted prior to the date of the Crown Lands Reserve Act. The Torbrook mine produces about 300 tons per day. The total production of iron ores in Nova Scotia, 1907, was 87,479 tons.

Antimony.—Antimony is known in only one district of Nova Scotia, viz., West Gore, Hants county. The ore occurs as stibnite, is auriferous, containing gold values as high as $200 per ton. In only one case—where a cross vein of quartz occurs—is there any free gold. Assays of high grade ores from the south vein, have 60·29 per cent antimony, and 2·66 oz. of gold per ton. Mixed ore and rocks cost $2.50 per ton. No. 1 mill ore equals $4 per ton. No. 1 ore alone—charging everything but development work against it—costs $40 per ton. Payment for ore is generally made per unit of antimony. No allowance is made for gold unless the ore carries over one-half ounce per ton. The price during the past year has varied from three shillings to twelve shillings per unit. About 50 men are employed in the Nova Scotia field.

In New Brunswick antimony has been known to exist since 1863. It occurs at Prince William, York county, 10 miles from Harvey station, on the Canadian Pacific railway, in the form of stibnite and native antimony. Though the occurrences are similar, they have not the gold bearing value of the Nova Scotia field. Shipments to Swansea, in January, 1907, gave the following analysis:—

Antimony	58·38 per cent.
Gold	2·24 oz. per ton.
Silver	1·75 "

The company operating the New Brunswick plant, is progressive, for it is about to install a dry method concentrating plant, bringing into use the system of separation by means of air blasts.

Limestones.—The limestone industry for general trade is practically confined to one district, viz., Marble mountain, Inverness, N.S., from whence it is shipped as raw stone to Prince Edward Island for burning, or consumed by the pulp mills of the country. Stone for building is sold f.o.b. at 75 cents per ton (2,240 lbs.). Stone for pulp mills is sold f.o.b., at $1 per ton. Prices for lime average about $5 per ton (10 bls. equal one ton) f.o.b., with price of package added. About 35 men are employed in this industry at Inverness. Two other quarries are operated by the Dominion Iron and Steel Company, Limited, and the Nova Scotia Steel and Coal Company, Limited, for flux purposes in the steel works.

Building Stone.—In both Nova Scotia and New Brunswick, granite and sandstone are mined extensively as building stones; since the Carboniferous formations. ranging in thickness from a few inches to nine feet, and having a variety of colours, are peculiarly suited for this purpose. In 1907, the depression in the building trade both of Canada and the United States, affected commerce in building stone business very materially, hence the production was comparatively small.

Brick Clays.—The trade of brick making has hitherto been a lucrative business in both provinces, since there is an unlimited supply of excellent clays for this purpose.

Metallurgical Industry.—Nova Scotia has for years been pre-eminent as a steel producing province. The principal operating establishments are the Dominion Iron and Steel Company; the Nova Scotia Steel and Coal Company, and the Londonderry Iron and Mining Company. The plant of the first named Company, is located at Sydney, Cape Breton, and covers over 440 acres. The works proper, consist of four blast furnaces 85 feet high and 20 feet bosh; ten 50 ton open-hearth tilting furnaces, a 35 inch blooming mill, and pit furnaces; a rail mill of 1,000 tons capacity; a rod mill of 600 tons capacity, and 500 Otto-Hoffman coke ovens in which all the by-products are saved, having a total capacity of 1,600 tons of coke per day. Another feature is a large foundry, also a well equipped machine shop, etc., capable of taking care of all mill and furnace work. Moreover, in connexion with these works, are about 47 miles of railway track, together with complete ore handling equipment, and receiving and shipping piers on the shore. In addition to this combination of manufacturing facilities the Company control their own ore and coal mines, limestone quarries, etc., rendering their organization one of the most complete in existence. This Company was incorporated in 1899, and is capitalized at $20,000,000; and produced in 1906, as follows:—

Pig iron	235,331	tons.
Billets and blooms	17,145	"
Rails	101,245	"
Wire rods	45,553	"

A commendable feature about this unique steel making plant is, that the employees are housed in 250 tenements of neat design, equipped with all modern hygienic improvements.

The plant of the Nova Scotia Steel and Coal Company, is situated at New Glasgow, N.S. The coal and iron mining properties are very extensive: located at Sydney, Trenton, and Belle Isle. The last named area is reputed to contain 6,000,000 tons of red hematite iron ore, with vessel shipping facilities of 1,500 tons per hour. The blast furnace (100 tons per day capacity) is at Ferona, while the steel smelting furnaces, and rolling mills, are at Trenton. The steel works at New Glasgow, have four Siemens open-hearth furnaces of 45 to 50 tons capacity—the output being about 150 tons of steel ingots per day; which are worked up into sheets, bars, and forgings. The Company was originally founded in 1882, and under the last reorganization is capitalized at $7,000,000. Last year the production was as follows:—

Pig iron	57,818	tons.
Steel	53,632	"
Coal (Sydney)	632,163	"
Coal (Pictou)	36,700	"
Iron ore	387,840	"
Limestone and dolomite	57,543	"

Total number of men employed, 4,210.

The Londonderry Iron and Mining Company, Limited, was incorporated in 1902, with an authorized capital of $1,000,000, and on its 30,000 acres of freehold lands, are mines containing large quantities of low sulphur and low phosphorus ores; and these ore bodies, it is claimed, have been traced through the entire length of the property. The general operating plant consists of one blast furnace, 75 feet high, and 18 feet bosh, having hot-blast regenerative stoves, and all necessary accessories. The ore crushing and mixing plant is one of the most modern and economic installations in the country. The Company has also, ninety-seven Bee-hive coke ovens, having a capacity of 150 tons per day; together with a Robinson coal washer, of 400 tons capacity per day. Railways of both narrow, and standard gauge connect all mines with the works, giving short, direct haul, and hence low freight rate. Allied to the pig iron works, is a pipe foundry, where cast iron water pipes are manufactured, and supplied to the cities and towns in the Maritime Provinces.

This somewhat lengthy abstract of Mr. Jennison's report will serve to give a good general idea of the extent and importance of the mineral and metal trades in the Maritime Provinces, and at the same time, obviate the necessity of a preliminary report.

COAL TESTS AT McGILL UNIVERSITY.

A systematic investigation of the coals of the Dominion was undertaken a little over a year ago by the Geological Survey, and is now being continued by the Mines Branch—with the assistance of certain specialists. Sufficient progress has already been made to justify the expectation that the main work on the coals of the Dominion will be completed by the end of next year.

The intention is to obtain a representative sample lot of coal from each important seam in each district, and to subject each of the samples so obtained to an exhaustive series of economic and chemical tests. The economic tests include coal washing, and, when necessary, dry cleaning; followed by boiler tests on the washed, and also on the original unwashed coal. Other portions are to be treated in gas producers, and the gas used in suitable gas engines provided with devices for measuring the power developed. It is proposed also to carry out coking tests on washed and unwashed portions of such coals as are suitable for the manufacture of coke.

In connexion with the above economic tests, a complete series of chemical analyses, and calorimetrical determinations, will be made of all coals. Analyses will also be made of the products of each washing and coking operation, and of the gases from the boiler and producer tests.

The Director has been able to secure the co-operation of the Mining and Mechanical Engineering Departments of McGill University, and thus to obtain not only competent technical assistance and a trained staff of experts and mechanics, but also to get the free use of admirably equipped laboratories.

A gas producer and gas engine plant of the most recent type have been purchased, and installed in a temporary fire-proof structure, which has been built close to the mining laboratories at McGill. To supplement the McGill equipment, other necessary and special apparatus have also been purchased.

The investigation is under the general direction of Dr. J. B. Porter, Professor of Mining Engineering, McGill University, who is individually responsible for the sampling, coaling, washing, and chemical work. The conduct of the boiler tests and producer gas engine experiments has been put in the hands of Mr. R. J. Durley, Professor of Mechanical Engineering, McGill University. The several portions of the work are conducted as follows:—

The economic tests indicated above are being carried out on a scale of approximately 40-50 h.p., and the periods of not less than one day. This scale has been adopted as being at once large enough to ensure practical service conditions, and yet small enough to be of value to a community which, in general, makes much more use of small than of large power plants.

Samples are taken by Mr. Theophile Denis of the permanent staff of the Mines Branch. Mr. Denis visits and examines each mine to be sampled, and has a ten ton lot of coal selected, sacked, and shipped under his own personal supervision. In taking this lot, he uses every precaution to secure average coal, and, as a check on the main lot, he personally secures a smaller sample, which he seals and sends direct to the chemist.

The main sample on arrival at the testing plant is unsacked, crushed to go through a two-inch screen, mixed thoroughly on a large cement sampling floor, sampled for the chemist, and then re-sacked and set out for treatment. This sampling is in charge of Mr. C. Landry, Chief Mechanic of the Mining Department of McGill University.

The coal washing is done in the McGill ore dressing laboratory; the apparatus used being a standard two compartment slide motion jig, built for the Department by the Fraser & Chalmers Company. This jig has been specially remodelled for coal washing work, and is provided with automatic feed and side discharge devices for automatically removing the slate and other impurities. The purified coal overflows into a drainage box in which it is collected and dried. The fine material passing down through the sieves is collected, and is either re-treated or wasted, depending upon its composition. Each of the tests is made on a lot of between three or four tons: which is first crushed, then sized, and then jigged in three separate portions—coarse, intermediate and fine—in order to secure the most accurate possible work. The products both of coal and waste are all recovered, weighed and sampled; but the coarse and fine products are mixed before sending them to the boilers. The coal washing work is checked by a series of tests with heavy solutions, followed by ash determinations. It would, of course, be possible in a laboratory to do extremely thorough washing at an expense disproportionate to the value of the coal; but this is not attempted, the aim being to reproduce commercial conditions. From a series of comparative tests made between laboratory work, and coal washing in standard plants, it is evident that this end has been attained, and the tests as carried on may be taken to represent average commercial work. The coal testing, under the direct supervision of Dr. Porter, has been carried out by Mr. H. F. Strangways and Mr. C. Landry.

Boiler Tests.

During June, July, and August, 1907, a series of thirty boiler trials were conducted in the boiler room of the Department of Mechanical Engineering, McGill University, on coal samples Nos. 1 to 16 (most of which were tested a second time after having been washed) the same boiler being used throughout. The equipment employed in these tests included a Babcock and Wilcox boiler, having 639 square feet of heating surface, and 16·79 square feet of grate area, an independent feed pump, weighing tanks, and standard scales for water and coal; together with the necessary apparatus for determining moisture in steam, analysing flue gases, and observing pressures and temperatures. Provision was made for supplying steam under the grate, and also for working under forced draft if required. The same pattern of fixed grate bars was used throughout the tests, and had air spaces, the area of which was 30 per cent of the total grate area. If different grate bars had been used for different grades of fuel, better economy in some instances would probably have been obtained; but it was felt that by using the same grate throughout, the tests would be more completely comparable with one another.

Before commencing the tests, the boiler was thoroughly scaled, cleaned and tested, and all brick-work around the furnace was rebuilt. Preliminary trials were then made with a standard coal (George creek), which showed that the whole equipment was in good order. The series of regular tests was then begun, the same fireman being employed throughout. It was not found possible to make more than one boiler trial with each sample of coal, and it was decided that in every case the same evaporation of 2,000 pounds of water per hour should be aimed at; this being a rate at which the boiler was known to give nearly its best efficiency. The results of the tests show, therefore, the rate at which each sample of coal had to be burnt in order to furnish a certain supply of steam. As a check, the heat losses in every case were determined as far as possible. All the tests were at least of ten hours duration, and the boiler tubes were, of course, cleaned before each run.

Since the practical working of a coal in the fire has a great bearing on its industrial value as a fuel, continuous notes were made of such points as the condition and thickness of the fire, the nature and amount of ash and clinker formed, the frequency of sluicing and cleaning the fire, and the method of firing found most suitable for each particular fuel.

It is proposed this year to carry out a further series of tests with the same boiler, and by the same methods.

The testing staff, under the general supervision of Mr. R. J. Durley, comprised:—

Mr. J. W. Hayward—in charge of the tests.
Mr. J. Blizard and Mr. D. W. Munn—observers and computers.

Mr. E. Stansfield and Mr. H. F. Strangways also gave considerable assistance.

The actual working of the boiler and auxiliaries was in the hands of:—

F. Balmfirth—in charge of the boiler plant, and J. Hoult—fireman.

Gas Engine and Producer Work.

The greater part of the summer of 1907 was spent in constructing the engine and producer house, and in installing and erecting the gas engine and producer equipment. Owing to the non-delivery of several important apparatus until September, it was not possible to carry out any producer tests. The plant is now nearly complete: the main engine and auxiliary machinery have been tried out; and standardizing tests are now being made as opportunity occurs. It is expected that the whole will be ready to commence regular tests by June 1st.

In deciding on the gas engine and producers to be installed, it was felt that a large producer and engine should not be used; since it is well known that the practical difficulties of working gas producers for power purposes are less in large than in small plants. Hence, it was desired to test, among other points, the suitability of the various Canadian coals for employment in a gas engine and producer plant of a size not beyond the means or needs of the small power consumer. An engine capable of giving 40 b. h. p. was, therefore, chosen. The equipment now in working order includes:—

One 40 B.H.P. horizontal gas engine, 220 R.P.M., single cylinder 12″ diameter, by 20″ stroke. (National Gas Engine Co., Manchester, England.)
One friction brake capable of taking 50 B.H.P.
One standard suction producer (for anthracite coals), with wet and dry scrubbers. (National Gas Engine Co.)
One special Sturtevant gas exhauster.
One tar extracting machine.
One standard gas meter (Pittsburg Meter Co.)
One steel gasometer, capacity 400 cubic feet,

together with the necessary apparatus for gas analysis: indicators, counters, gas calorimeters, electric and other thermometers, and accessories. Preliminary standardizing tests have shown that, on a twenty-four hour run at full load. the plant has a consumption of under 1·3 lbs. of coke per b. h. p., per hour; the calorific value of the coke being 12,800 B.T.U., per pound.

There is also on order, and nearly ready for test, a second producer, of the down draft type, which will be used for such fuels as cannot be burnt in the suction type producer.

This plant was designed, and its installation carried out, under the supervision of Professor R. J. Durley, and the preliminary tests made by Mr. J. W. Hayward. The machinery and its operation have been placed in charge of Mr. J. S. Gardiner, who will superintend the working during the forthcoming tests.

In connexion with this plant it is to be observed that, when, in the early part of 1907, the coal tests were decided upon, no maker could be found who would guarantee the operation of a small gas producer on bituminous coals of the kind met with in many parts of Canada, containing as they do, a large percentage of volatile matter. A producer capable of working only with lignite could have been ordered at that time, but would have been useless for much of the work to be done. It was, therefore, necessary to spend much time in further investigation, and this has led to unavoidable delay in the commencement of the tests. It is possible that unforeseen difficulties may still stand in the way of the utilization of certain of the coals to be tested, but it is believed that the two producers, with the aid of the tar extracting and gas cleaning apparatus now installed, will be capable of giving power gas from any kind of coal likely to be submitted for test.

The coking tests will be deferred until a later date, as it is desirable to first complete the general investigation: analysing and testing the coals as above outlined. It is proposed to have the coking experiments done under separate supervision at one of the large modern coking plants; as laboratory tests on coking have not proved reliable, even when carried out on a very large scale.

The chemical work is done in Dr. Porter's private laboratory, which has been set apart for this exclusive service. In addition to the regular equipment of the laboratory, calorimeters by Ostwald and Boys have been procured, and such other special apparatus as has been found necessary to make the equipment as complete as possible for the investigation of fuels. The chief chemist is Mr. Edgar Stansfield, M.Sc.

Owing to the very tardy deliveries of some of the machinery and apparatus ordered from abroad, and delays due to the disastrous fires which occurred at McGill last April, it was impossible to get work started as promptly as had been hoped; but, nevertheless, the results for the year are very encouraging. Mr. Denis has visited Nova Scotia and New Brunswick, and has taken altogether nineteen samples, aggregating about 175 tons. These samples have all been tested in the boiler plant. Of the coals thus far received, twelve have been sufficiently impure to require washing These twelve have been washed and the washed material tested in the boiler plant.

This work completes the examination of coals from the eastern section; with the exception of the properties controlled by the Dominion Coal Company—which Company will furnish material during the present year. It is expected to be able to examine the coals from the western fields next season.

There have been completed to date—counting duplicate runs—fourteen washing tests, thirty boiler tests, and a very large number of chemical analyses. In addition to this regular work, there have been numerous experimental operations for the purpose of adjusting and testing apparatus, and for arriving at standard methods of high accuracy. At least three-fifths of all the work done thus far has been of this character.

It may be noted that all colliery managers have offered the Department every facility in taking samples, and have given the coal free of charge.

The railway companies have hauled the coal free in all cases, and have thus relieved the Department from what would otherwise have been a very serious item of expense.

CHEMICAL LABORATORIES.

The two laboratories in connexion with the Department of Mines: one in the Geological Survey Branch building, Sussex Street, conducted by Mr. F. G. Wait, assisted by Mr. M. F. Connor; and the other in the Mines Branch building, Wellington street, conducted by Mr. Harold A. Leverin, have done effective work during the past year. In the former—from November 28, 1908: the date of transfer—140 specimens were examined and reported upon; while in the latter—during the whole year—460 samples were received, and analysed quantitatively: this being in addition to the examination of numerous specimens sent in for identification.

The Wellington Street laboratory, which was established for essentially practical work, has been equipped with complete apparatus for the assaying of gold and silver. For this particular work, as well as in the analysis of iron ores generally, Mr. Leverin's facilities are superior to those available in the Sussex Street laboratory; but it should be pointed out that, much of the work done in the latter place, consists of complicated and time-absorbing rock analyses.

The establishment of a second laboratory, equipped with modern apparatus for electro-chemical analysis, and rapid determinations of the common ores; together with up-to-date instruments, etc., for necessary research work, has brought forth gratifying results; while the combination of the two laboratories has proved to be a harmonious and economic arrangement.

STATISTICS OF MINERAL RESOURCES.

The combined reports of the Division of Mineral Resources and Statistics: one, a statement of the specific work done by the Division—the other, a preliminary statistical report on the mineral production of Canada in 1907 (already issued in pamphlet form) —show that, while the work accomplished is of national importance, interesting alike to manufacturer, investor, and the general public, it is manifestly only in its initial stages, and if improved and augmented along the lines indicated in Mr. McLeish's statement, is destined to be an invaluable factor in contributing to the country's growth in commerce and industry. The Division has been greatly inconvenienced during the past year, through the decrease in the number of technical officers on the staff, viz., from three to one. And although the commerce and trade of the Dominion have been increasing with rapid strides, and hence entail additional labour in compiling the necessary data of progress, there has been no increase in the clerical staff, which consists of two clerks only. If the work of the Division is to keep pace with the development of the mineral and metal resources of the Dominion, and the statistics published are to be comprehensive, exhaustive, and thoroughly reliable, it will be necessary, not only to increase the present office staff, but to organize a sectional field force for the gathering of statistical data, on mining and metallurgical industries; fuels and non-metallic minerals—such as asbestos, gypsum, salt, abrasives, etc., and structural materials—including clay products of all kinds.

The suggestions of the chief of the Division of Mineral Resources and Statistics are the result of repeated conversations had with him, and therefore, have my unqualified endorsation.

DOMINION OF CANADA ASSAY OFFICE.

VANCOUVER, B.C., May 13, 1908.

During the fiscal year ended March 31, 1908, 46,540·25 ounces of bullion, valued at $751,693·97, were received and assayed. These deposits were derived from the following sources:—

Source.	Deposits.	Weights.		Value.
		Before melting.	After melting.	
	No.	Oz.	Oz.	$ cts.
Yukon	70	9,108·12	8,937·23	150,592 21
British Columbia	396	34,347·69	33,403·98	553,458 53
Northwest Territories	2	67·14	57·24	1,054 37
Ontario	2	36·23	32·61	393 25
Alaska	12	2,981·07	2,974·79	45,835 61
	482	46,540·25	45,405 85	751,693 97

	Oz.
Weight before melting	46,540·25
Weight after melting	45,405·85
Loss by melting	1,134·40
Loss percentage by melting	2·4374

The following table shows the business done by the Assay Office since its establishment:—

Fiscal Year.	Deposits.	Weights.	Value.
	No.	Oz.	$ cts.
1901-2	671	69,925·67	1,153,014 50
1902-3	509	36,295·69	568,888 19
1903-4	381	24,516·36	385,152 00
1904-5	443	29,573·73	462,939 75
1905-6	345	21,050·83	337,820 59
1906-7 (9 months)	269	20,695·84	336,675 65
1907-8	482	46,540·25	751,693 97

The following is a statement of difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office from April 1, 1907, to March 31, 1908:—

Value bars, Seattle Assay Office	$774,720 01
Value bars, Dominion of Canada Assay Office	773,726 55
	993 46
Less—Profits chargeable to 1906-7	47 83
Difference in favour of Dominion of Canada Assay Office	$945 63

Statement of Deposits of Gold and Earnings.

Deposits of gold		$773,726 55
Less—Bar purchased in 1906-7 on hand March 31, 1907, and included in above		22,032 67
Net deposits, 1907-8		$751,693 88
Earnings—		
Value of sweeps sold to Jos. Mayer & Bros	$371 73	
" silver recovered from solution sold to Jos. Mayer & Bros	69 69	
" residue and cornets sold to Assay Office, Seattle	1,085 74	
" 85 empty Winchester bottles sold to B. C. Assay and Chemical Supply Co.	12 75	
For three special assays	7 50	
	$1,547 41	
Difference between amount paid and received for bullion	945 63	
		$2,493 04
Percentage of net expenses to deposit	1·43187	

The following is a statement of appropriation, receipts and expenditure for the year ended March 31, 1908, and shows the unexpended balance to be $5,236.66.

	Appropriation.	Expenditure.
Appropriation 1907-08	$16,000 00	
Receipts per the foregoing statement	1,547 41	
Difference between amount paid and received for bullion	945 63	
Rent account		$2,100 00
Fuel account		322 51
Power and light		139 51
Postage and telegrams		86 76
Telephone		66 20
Express charges		129 92

	Appropriation.	Expenditure.
Assayers supplies		250 50
Printing and stationery		53 28
Premium on bonds		570 00
Contingencies		108 51
Wages—		
G. Middleton		2,500 00
J. B. Farquhar		1,700 00
D. Robinson		1,500 00
Thos. Evans		429 19
E. Tierney		820 00
A. Kaye		1,600 00
G. B. Palmer		345 00
C. Fitch		35 00
Balance		5,236 66
	$18,493 04	$18,493 04

Unexpended balance March 31, 1908, $5,236.66.

Inventory of Residues and Supplies on Hand in Assayer's Department, March 31, 1908.

Proof gold	15·28 oz.
Proof silver (large discs)	110·02 "
" (small discs)	37·29 "
Cupels, about	8,000
Bone-ash, about	10 lbs.

1 Winchester, NH_4 HO.

$\frac{1}{3}$ " HCL.

14 " HNO_3.

8 spare muffles.

50 2¼″ scorifiers.

10 4″ "

9 fireclay muffle supports.

24 " plugs.

13 " end pieces.

8 " doors.

100 lbs. C.P. lead foil.

J. B. Farquhar,
Chief Assayer.

Supplies on hand in the Melting Department.

3	sets of linings, with supports and covers complete, for			No. 1	furnace.
3	"	"	"	2	"
2	"	"	"	$4\frac{1}{2}$	"
2	"	"	"	7	"

35	graphite crucibles...............	No. 10
90	"	16
64	"	30
28	"	40
65	" ....marked	° ° °
6	crucible covers...............	16
10	"	35
11	"	50

2 graphite stirrers.
9 lbs. pot. nitrate.
60 lbs. carb. soda.
69 lbs. borax glass.

D. Robinson,
Chief Melter.

Changes in Assay Office Staff.

Mr. Geo. McCaw, assistant melter and janitor, resigned on account of ill health, April 9, 1907.

Mr. Thos. Evans, appointed to succeed him on May 22, 1907. Resigned November 13 1907. Succeeded by Mr. G. B. Palmer.

Proposed New Assay Building.

The rent paid for the building occupied by the Dominion of Canada Assay Office in Vancouver, B.C.—since its establishment in 1901, is as follows:—

July 1901 to July 1906 at $1,200 per annum.
July 1906 to July 1908 at $2,100 per annum.

Present lease for 17 months from July 1, 1908, at $2,700 per annum.

During the seven years of occupancy the rent has increased 125 per cent.

In view of this high rental, it was deemed advisable to take a lease for seventeen months only, and I strongly recommend that, in the meantime, steps be taken to establish the Assay Office in permanent quarters, by the purchase of a suitable lot, and the erection of a properly designed fire-proof building.

Proposed Transfer of Gold to the Royal Mint at Ottawa.

When the original plans for the Royal Mint of Canada were first prepared, I recommended in a memorandum to the Hon. W. S. Fielding, Minister of Finance—under date November 5, 1901—that provision be made for a refinery in connexion with same. This suggestion was based upon the following reasons: (1) That there are no refineries in Canada. (2) That the only available bullion coming to the Mint from Canadian sources, would be unparted bars from the assay offices of the Dominion: representing gold dust and nuggets from the gold bearing districts: averaging 725 fine, and containing silver, copper, and other base metals. (3) That this alloyed bullion would have to be sent to the refineries of either the United States or Great Britain for conversion into fine bars suitable for coinage. (4) That this plan would prove to be very inconvenient, if not impracticable; hence the proposed establishment of a refinery at Ottawa. This recommendation is now to be carried out, and instead of the unparted bars of gold from the Dominion Assay Office in Vancouver, B.C., being sold to the Seattle Refinery of the United States government, I recommend that this bullion be—in the near future—transferred to the proposed refinery in connexion with the Royal Mint at Ottawa.

REPORT OF THE ACCOUNTANT.

Statement of Appropriation and Expenditure by Mines Branch, for year ending March 31, 1908, showing Unexpended Balance to be $16,027.64.

	Appropriation.	*Expenditure.*
Amount voted by Parliament	$55,000 00	
Civil government salaries		$3,991 66
Publication of reports		246 24
Travelling expenses		187 30
Peat pulping machine		297 57
Publication of maps		409 22
Investigation *re* gas producers		236 53
Furniture account		99 83
Investigations *re* copper deposits		30 40
Laboratory		2,161 31
Miscellaneous		338 97
Wages		17,987 25
Instruments		2,020 15
Printing and stationery		1,045 29
Books and periodicals		355 17
Investigations *re* iron ores		2,221 48
Investigations *re* peat and coals		1,282 52
Mineral statistics		900 96
Mining and metallurgical industries		4,902 19
Mapping material		258 32
Balance unexpended and lapsed		16,027 64
	$55,000 00	$55,000 00

Jno. Marshall,
Accountant, Dept. of Mines.

During the year, numerous requests were received from all parts, for information on the mining and metallurgical industries of the Dominion; on reported mineral occurrences and deposits and for advice on the economic smelting of ores: particularly by the electro-thermic process. The correspondence for the fiscal year ending March 31, 1908, amounted to 3,772 communications received, and 2,706 letters sent out—not including the correspondence in connexion with the Division of Mineral Resources and Statistics.

I have the honour to be, sir,

Your obedient servant,

EUGENE HAANEL,

Director of Mines.

PRELIMINARY REPORT ON THE IRON ORE DEPOSITS OF VANCOUVER AND TEXADA ISLANDS.

April 2, 1908.

Dr. Eugene Haanel,
Director of Mines
Department of Mines,
Ottawa.

Sir,—In accordance with your instructions to make an investigation of the iron ore deposits on the coast of British Columbia, with a view to furnishing information for an eventual iron industry, I left Ottawa, June 2, 1907, for Victoria, B.C., to get information regarding localities of reported iron ore occurrences. I desire to express my appreciation of the unfailing courtesy of Mr. W. F. Robertson, Provincial Mineralogist, and all others who have given aid and information in connexion with my work.

In attempting to give a description of the iron ore occurrences of the coast, one is immediately confronted with the fact that, with very few exceptions, the locations have not received any more development than the mining law of the Province compels the holder to do. The development work done is, therefore, limited to surface strippings, shallow open cuts and tunnels. This is quite natural; for as long as the property owners had no positive assurance of a market for their iron ore, they could not, or would not, invest more capital in developing their claims than was necessary to meet the requirements of the mining laws. Since this development, these claims were crown granted, and have been allowed to remain untouched. As a result, trails have become overgrown by brush; making it in some places difficult even for a person well acquainted with the locality to find the locations.

The districts visited were:—

Sooke, Gordon river, Sarita, Cooper island, Severals claims in Alberni canal, Anderson lake, Seshart, Maggie lake, Kennedy lake, Head bay (Nootka sound), West arm (Quatsino sound), June group, Ingersoll river, Klaanch river, Quinsam river, Salt Spring island, and the Iron Mines (Texada island).

In this report, only those properties which are more likely in the near future, to be commercially important will be dealt with: leaving the others visited, for the final report. Some of these latter may possibly, by further development, prove to be of some commercial value, while others have absolutely no features to indicate that they will be iron ore producers.

GENERAL NATURE OF ORE DEPOSITS.

With the exception of the bog ore deposits at Quatsino sound, and a small deposit of hematite on Salt Spring island, which in places seems to change into magnetite, all the properties visited show magnetite. There is, moreover, a remarkable similarity amongst these different deposits of magnetite, so far as geological conditions are concerned. They all are in the immediate vicinity of crystalline limestone, if not in contact with it, and occur where it is in close proximity to igneous rocks.

The examination of the main geological features of Vancouver island was made in 1885 by the late Dr. G. M. Dawson, and I beg to refer you to the report of the Geological Survey of Canada for 1886 for the geological description.

The magnetites of the coast are high in iron, and few, if any, have a phosphorus content exceeding 0·05 per cent, in most cases considerably below this figure. On the other hand, they are, as a rule, high in sulphur, though not to such an extent as to render them unfit for smelting.

Gordon River District.

The Gordon river flows from the north into Port Renfrew, or Port San Juan, as it is locally known, which is about sixty miles from Victoria on the west coast of Vancouver island. Up this river and its principal tributaries, the country rocks are chiefly crystalline limestones and igneous rocks, of which granites and diorites are most in evidence. A considerable number of mineral locations covering showings of magnetite have been made here, but many of them will not prove of sufficient body to warrant mining, and seem to have been staked, more for the purpose of keeping other parties out of the field than for their ore contents. On the other hand, some promising prospects were noticed, on two of which more development had been done than one usually finds to be the case on the island.

The Baden-Powell and Little Bobs mineral claims are situated up the Gordon valley about seven miles from salt water. An outcrop of magnetite is found on the flank of a ridge, along which it can be traced for 350 feet. In several places on the ridge a sharp contact between the ore and the granite was observed. About ninety feet below this contact a tunnel 114 feet long had been run directly into the hill, showing magnetite for its full length, with the exception of a diorite dike eight feet wide about thirty feet from the mouth of the tunnel.

An average sample of the ore taken along the tunnel gave the following analysis:—

	Per cent.
Silica	8·88
Iron	58·30
Sulphur	2·75
Phosphorus	0·013

About thirty-five or forty feet below this tunnel another tunnel had been run in the same direction for 114 feet into the hill, going through limestone and diorite. The last few feet, however, show magnetite dipping in towards the hill.

The *Sirdar* mineral claim is situated two miles farther up the valley, and is very similar to the Baden-Powell and Little Bobs. The magnetite outcrops along the face and brow of a ridge for about 160 feet. About fifty feet below the top of the ridge a tunnel had been run 103 feet into the hill, showing the width of the ore to be about eighty-two feet. An average sample taken along the tunnel gave the following analysis:—

	Per cent.
Silica	8·52
Iron	56·57
Sulphur	2·75
Phosphorus	0·121

The *Conqueror* mineral claim is situated a little farther up the valley on Bugaboo creek, which flows into the Gordon river. The claim is some nine miles from the navigable water of Port San Juan. A solid body of magnetite about forty feet high is exposed in the canyon of the creek, and over which the creek forms a water fall. The ore has a maximum width of about sixty-three feet on the east side of the creek, but becomes narrower on the west side. On the east side, the ore body is stripped for about eighty feet from the creek to where it runs into the gravel bank. At the foot of the bluff a tunnel fourteen feet long had been run into the ore, showing solid magnetite. A sample taken along the tunnel gave the following analysis:—

	Per cent.
Silica	4·51
Iron	67·09
Sulphur	1·60
Phosphorus	0·009

On the up stream side the ore body is confined by a diorite dike, six feet wide, crossing the creek nearly at right angles. Beyond this dike, outcrops of magnetite were noticed on both banks of the creek for a distance of about sixty feet, and on the east side for fifteen feet farther. Here, in several places, the ore seems to lie as a blanket on top of a green igneous rock. A couple of hundred feet east of the creek some outcrops of magnetite were reported to have been struck by strippings, but the workings had caved in at the time of my visit. Between these strippings and the creek a strong magnetic attraction was noticed in several places. From the existing development, it was, however, impossible by a superficial examination to get any exact information as to the extent of the ore body, or bodies, as the solid formation is effectually covered by a sandy loam. A magnetometric survey would undoubtedly give a large amount of information here.

The same may be said about the *David* mineral claim, east of the Conqueror, and adjoining Sirdar on the west side. Within a distance of 400 feet along a slope, some strippings have exposed a good magnetite in several places, but do not give sufficient information to warrant an estimate of the extent of the ore.

Head Bay.

Head bay forms the upper end of Tlupana arm, Nootka sound. On a ridge running north-west and south-east, four outcrops of magnetite can be seen at intervals along a contact of crystalline limestone and diorite, about a mile from the deep water of the bay. These outcrops are from 170 to 200 feet long, and from 40 to 55 feet maximum width. A little farther south, several smaller outcrops were noted, showing that there is, undoubtedly, strong mineralization by iron here. Up to the present time, no work has been done to show the extent of the ore, with the exception of one place where some stripping had been done, and an open cut made into the ore, showing the width to be about fifty-five feet. The ore here is of an excellent character, a sample taken along the open cut giving the following analysis:—

	Per cent.
Silica	6·10
Iron	66·17
Sulphur	0·017
Phosphorus	0·016

West Arm Quatsino Sound.

The country north of the west arm of Quatsino sound, has, during the last few years, attracted much attention, owing to the discoveries at several points, of limonite in the form of bog ore. Many of the claims staked do not show any indication which can warrant the supposition that the ore is in commercial quantities, but must be considered as another case of undue prominence being given to minute objects.

I wish to mention a group of claims which give the best showings of bog ore, more on account of the character of ore than their importance as shown by surface indication. These claims are situated about one mile from navigable waters, five miles west of Coal harbour. They lie in and on the border of swampy basins, and partly on the ranges of hills adjoining these. The ore has been exposed by some strippings and open cuts, and a number of outcrops are also visible in the banks of some small creeks. The ore in these bogs owes its origin to the alteration of iron pyrites, with which the surrounding hills are heavily charged. Although bog ore deposits have been utilized under favourable conditions in certain parts of Canada and other countries; here, as the overlying soil is in many places quite deep, and the ore often mixed with peat, stumps, etc., which must—at least in part—be removed from the ore, economic exploitation is, in my opinion, somewhat doubtful. Whether the extent and thickness of ore would warrant the cost of mining, only a systematic drilling of the properties can determine.

Average samples of the ore from two locations gave the following analyses:

	I. Per cent.	II. Per cent.
Insoluble matter	2·32	1·40
Iron	54·46	56·97
Sulphur	0·150	0·447
Phosphorus	0·038	0·038

Klaanch River.

Nimpkish lake, which is about fifteen miles long and one mile wide, empties through Nimpkish river into Broughton strait, at a point directly opposite Albert bay. The Iron Crown mineral claim is situated about seven miles up the Klaanch river, which flows northwest into the south end of Nimpkish lake. An exposure of magnetite extends along the face of the river bank for some 180 feet. The height of the bank is about eighty or one hundred feet, forming at same points, cliffs of magnetite twenty-five to thirty feet high. The top of the bank is covered with soil, and no work had been done to ascertain the width of the deposit; but to judge from the magnetometric survey made, the width at the south end may be estimated at not less than one hundred feet, decreasing towards the north. A sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter	4·12
Iron	64·23
Sulphur	0·233
Phosphorus	0·008

Farther up the hill, about 650 feet from the river, several showings of magnetite occur along the ridge, indicating the length of the deposit to be about 360 feet. The width may be estimated at sixty feet. An average sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter	5·30
Iron	63·89
Sulphur	0·017
Phosphorus	0·010

No more outcrops were visible, but the magnetic curves north of these two deposits show two others, one of which is about 480 feet in length. A chart of vertical magnetic intensity showing the extent and location of these will accompany the full report.

Quinsam River.

The Quinsam river is a tributary to the Campbell river, which flows into the strait of Georgia at a point about thirty-five miles north of Comox, and directly opposite the south end of Valdes island. The mineral claims are situated up the Quinsam river, about thirteen miles from the coast. Magnetite outcrops on the north bank of the river, in a bluff about eighty feet high. Part of the face of this bluff has been stripped for fifty-three feet in width, showing solid magnetite, without having uncovered the contacts with the country rock. About forty feet above the river a tunnel had been driven into the hill, following the strike of the ore. The tunnel was sixty-six feet long, entirely in magnetite.

A sample taken along the tunnel gave the following analysis:—

	Per cent.
Insoluble matter	7·00
Iron	56·45
Sulphur	0·530
Phosphorus	0·014
Copper	0·700

Another sample taken across the face of the bluff above the tunnel gave the following analysis:—

	Per cent.
Insoluble matter	11·00
Iron	59·77
Sulphur	0·533
Phosphorus	0·024

Following the crest of the ridge in a NNW. direction, some outcrops and surface strippings were noted, showing the ore to be continuous for a distance of about 350 feet. The ore is generally free from admixture with country rock, though containing some sulphides of copper and iron. On the south side of the river some small outcrops of magnetite may be seen along the slope, and strong magnetic attraction observed in several places. The deposits being covered with soil, the extent of the ore could not be observed without a more detailed magnetometric study, of which the time did not permit. A few hundred feet farther up the valley, a seam of coal outcrops on the north bank of the river.

Texada Island.

The iron ore deposits which occur on the western slope of Texada island, from three to four miles north of Gillies bay, have been known for many years, and were taken up for iron mining as early as 1875. The principal ore deposits are on the Prescott, Paxton, and Lake properties.

The *Prescott* has received the most development, and has during several years, shipped ore to Irondale, Washington. The magnetite outcrops about 850 feet from the shore, in a big bluff on the brow of a steep, rocky hill, at the contact between granite and crystalline limestone. The deposit has been opened at three levels. At an elevation of 365 feet an open cut had been made into the hill, showing magnetite penetrated by granite dikes. Sulphides of copper and iron are also common here. The second level is situated forty feet above. A considerable amount of ore has been taken out from an open cut, which shows, now, a face of magnetite forty feet wide, and about one hundred feet high.

The ore here includes small patches of calcite and fragments of volcanic rocks, forming in places a species of ore breccia. More or less sulphides of copper and iron are also present.

A sample of the ore dump gave the following analysis:

	Per cent.
Insoluble matter	6·46
Iron	62·57
Sulphur	0·403
Phosphorus	0·024

The third level is situated sixty feet above the second, at an elevation of 465 feet above sea level. The face of the quarry is about fifty feet high and fifty feet wide, showing the same kind of ore as at the second level. The thickness of this ore body, can be estimated at about eighty feet. A sample of the ore gave:—

	Per cent.
Insoluble matter	12·00
Iron	58·76
Sulphur	0·113
Phosphorus	0·011

About 430 feet below the top of the bluff, at about 130 feet above sea level, a tunnel had been run into the hill under the quarry. The length of the tunnel is 630 feet, going through granite and felsitic rocks, and showing solid magnetite for the last seventy-five feet on the west side of the tunnel, and for forty-five feet on the east side. A sample of the ore taken along the tunnel, gave the following analysis:—

	Per cent.
Insoluble matter	4·37
Iron	63·27
Sulphur	0·347
Phosphorus	0·006
Copper	0·09

From the Prescott mine the contact between the limestone and the eruptive rocks may be followed for about 1,200 feet farther up the hill, and after making a sharp bend, down hill again for about 800 feet; it then takes a more easterly direction, making some windings to the Paxton mine, and thence to the Lake mine. Strong magnetic attraction in some places, and numerous outcrops of magnetite were noted along this contact, some of them reaching a width of about seventy feet. As the rock formation is to a great extent covered by soil, the magnitude of these deposits could not be ascertained; but the character of these contact-deposits on the borders of the granite indicates the importance of closely examining the contact of the eruptive rocks with limestone. On account of the lateness of the season, a magnetic survey could not be performed.

The *Paxton* mine is situated about 3,500 feet east of the Prescott mine. An outcrop of magnetite extends along the face of a ridge for some 500 feet. Two open cuts had been run into the hill, passing through granite—which seems to form the hanging wall—and then into ore. From the face of the east cut, a tunnel forty-five feet long, shows solid magnetite, carrying some sulphides of copper and iron.

A sample taken along the tunnel gave the following analysis:—

	Per cent.
Silica	4·47
Iron	64·48
Sulphur	1·87
Phosphorus	0·002
Copper	0·22

The *Lake* mine is situated about 1,300 feet to the east of the Paxton. The ore can be traced along the face and brow of a ridge for some 200 feet. The height of the ore bluff is about eighty feet, with a maximum width on the surface of about 100 feet. Crystalline limestone forms the footwall, and a diorite overlies the ore in places. An open cut had been made in the ore body, showing a good clean magnetite. About 1,000 tons of ore are reported to have been shipped last summer. An average sample of the ore gave the following analysis:—

	Per cent.
Silica	8·33
Iron	59·57
Sulphur	0·137
Phosphorus	0·024
Copper	0·08

From what has been said, it may be understood that it is impossible from present developments to give actual figures as to the ore in sight, without doing injury to the owners of certain properties; but with a fuller development, the better properties should be capable of supplying a modern blast furnace for many years. A well equipped and properly managed plant, using these magnetites, thoroughly roasted, could produce a good quality of pig iron.

FUEL.

In regard to fuel, the east coast of Vancouver Island has a good supply of coal. The output from the collieries is estimated for the year, at 1,325,000 tons of coal. During the year, about 17,000 tons of coke were made. The Provincial Mineralogist of British Columbia reports the coke to contain from 15 per cent to 16 per cent ash; but thinks that, by a more careful separation of shale from the coal, the ash could be reduced to about 12 per cent with very low phosphorus contents.

FLUXES.

The limestones frequently met with on the coast are exceptionally pure, and free from deleterious elements, and offer, therefore, a good flux. The supply may be said to be practically unlimited. An analysis made at the laboratory of the Department of Mines gave:—

	Per cent.
Insoluble matter	1·0
Iron oxide and alumina	0·5
Calcium carbonate	97·0
Magnesium carbonate	0·7

TRANSPORTATION.

Cheap transportation of the raw materials is one of the most important factors in a successful iron industry. The many inlets which indent the coast and the islands of British Columbia, offer great advantage to transportation; as the iron ores, limestone, and coal deposits are situated in nearly all cases close to these navigable waters. Navigation being open the year round, offers still another advantage to the blast furnace man and the miner; saving them from large expenditure in stocking and rehandling the raw materials. It may, therefore, be said that the coast of British Columbia is singularly fortunate as regards cheap assembling of raw materials.

LABOUR AND MARKET.

So far, the conditions have been found favourable for the establishing of an iron industry on the coast; but when the question of labour and market is considered, the matter is somewhat different. The cost of labour is higher in British Columbia than in the other provinces of the Dominion, and this province may not, for some years to come, have a sufficient market to support an iron industry. A large market is certainly offered by the western United States, but is protected by a custom duty of $4 per ton on pig iron. It is questionable therefore, whether it would be possible for a British Columbia smelter to compete in the American market—under present conditions—with other iron producers of the world.

Not having had the opportunity, as yet, to gather sufficient information and figures in regard to this matter, I propose to take up the question at greater length in my full report.

Yours respectfully,

(Signed) EINAR LINDEMAN.

INVESTIGATION OF CERTAIN ALLEGED IRON ORE DEPOSITS IN QUEBEC AND ONTARIO.

(Report of B. F. Haanel, B.Sc.)

OTTAWA, January 11, 1908.

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—In accordance with your instructions, I visited—on June 3, 1907, the iron property of Dr. James R. Reed, of Reedsdale, Que., situated near Kinnears Mills, Megantic county, Quebec; for the purpose of examining the work done in diamond drilling.

On September 8, I left for Penetanguishene, Ont., to examine, and, if possible, make a magnetic survey of some alleged iron ore deposits; and, on October 9, went to Cairnside, Que., to investigate reported occurrences of iron ore.

Owing to the work of editing the monographs on 'Graphite,' and on 'The Iron Ore Deposits along the Ottawa and Gatineau rivers,' by Fritz Cirkel, M.E., it was impossible to carry out the original work planned for the summer months, viz., the examination of the iron ore deposits along the Kingston, and Pembroke railway; and Central Ontario railway; to complete the report of the iron ore deposits of Ontario. The following is a detailed report of the above-mentioned field work:—

Iron Ore Property near Kinnears Mills, Megantic County, Que.

Two years ago, having made a magnetic survey of this property—completed about June 22, 1905—I prepared a preliminary map of the vertical intensity of the ore field, on which was located the position for a drill hole, necessary to determine the value of this iron ore deposit. Up to the present time the owner has not done any drilling or boring, to prove the value of the property. In January, 1907, however, an option to buy, was given to a Chicago party, with the understanding that 500 feet of diamond drill holes would be put down. This option was soon after sold to Mr. Drummond, who began work with a Sullivan diamond drill.

After several week's boring, the operator succeeded in putting down only 115 feet of holes; and as these bore-holes were not placed according to the directions on the official map, the owner began to doubt whether his property was being properly proved; hence, the application to the Department of Mines.

Upon arriving at Kinnears Mills, I found that the men had been ordered to stop work, and that the drill, and auxiliary machinery had been taken off the property, and moved to the railway station—a distance of some ten miles.

The two holes drilled, consisted of one vertical, close to an outcrop, and the other, situated about 250 feet north-west and 60 feet south from this, drilled at an angle of 45°, or perpendicular to the dip of the ore body.

Accurate measurements of the positions of these two holes were taken, and indicated on the map in the office of the Mines Branch, showing the vertical intensity of the general deposit.

As the cores taken from the holes had been packed, and sent to Montreal, there was no opportunity of forming an opinion as to the justification of putting down the holes in the positions mentioned above; although the second hole was placed very near the position originally indicated on the map, and which would—if put down to a sufficient depth—have determined the extension of the deposit in depth, and the feasibility of further development.

According to a resident of Kinnears Mills, who was employed by the man operating the drill, the first hole penetrated 25 feet of schistose rock and some calcite, and about 40 feet of magnetite, after which the foot wall, consisting of schist, was struck.

The second hole penetrated 15 feet of schist, when the work was stopped.

Judging by means of the work done, no rational conclusion as to the value of the property could possibly be adduced—even if the drill cores had been available for examination; since the only hole which might have been of use in helping to form an opinion, was only put down to a depth of 15 feet: not deep enough to penetrate even the hanging wall of the deposit.

Examination of Reported Occurrences of Iron Ore at Penetanguishene, Ont.

Following your directions, I went on September 8, 1907, to Penetanguishene. Ont., to make an examination, and if necessary, a magnetic survey of some occurrences of iron ore, said to exist there.

The properties on which there was reported to be iron ore, were lot F, con. 19, Simcoe county, Tiney township, about eight miles from the town of Penetanguishene; and Park lot 53, west of Park street, within the town of Penetanguishene.

It was found that both the above-mentioned lots, as well as the country in the vicinity, were entirely free from magnetic disturbance due to the presence of a magnetic ore body, and hence precluded the possibility of a magnetic survey.

In the first lot examined—Park lot 53, in the town of Penetanguishene, near the Grand Trunk Railway tracks, which run through the lot—was a spring which carried in solution a small amount of iron, precipitated as yellow ochre on the bottom and sides of the small rivulet which was discharged from it. This yellow ochre was too small in amount to render it of any commercial importance.

Surrounding this lot, No. 53, on the south, and east, and three or four hundred feet from the spring, were terraced beaches, presumably covered by Lake Huron in past ages. As these beaches contain some hematitic, and magnetic iron sands, it is evident that the iron carried in solution by the water issuing from the spring, had its origin in the beaches; having been leached out by the action of rain, and the melting of snows.

About 2,000 feet from Georgian bay, on lot F, con. 19, Simcoe county, there is a deposit of bog iron ore, or paint ore, on the side of the hill. Similar patches occur on different parts of this hill, and two samples from the most promising were selected for analysis: one a light yellow, and the other a reddish brown earthy bog ore. (See following analysis).

On the top of this hill is a bog filled with roots, decomposed leaves, etc., which was once covered with large trees—elm, pine and oaks; but these have been cut down, leaving only a few trees, not suitable for lumber. A hole dug 4 or 5 feet deep, slowly filled with water, and revealed nothing more than a dark soil below. On the side of the hill containing the deposits of bog ore, a shovel put down about a foot in several places, proved the thickness of the bog ore to be not more than 12 inches in maximum thickness.

About 2,000 feet from this bog, traces of hematitic, and magnetic iron sands could be seen along the beach washed by the waters of Georgian bay; and although no traces of these sands were discovered in the above-mentioned hill, or elevated land, it is probable that the deposits of bog iron ore referred to, were also leached out by rain and the melting of snows, as in the case of the lot previously examined in the town of Penetanguishene.

Owing to the thick vegetation and underbrush covering the side of the hill, it was not possible to form an estimate of the extent of the deposit, or determine whether deposits other than those visible exist. Stripping will have to be done, or shallow test pits put down, in several places, in order to thoroughly prove this property; but from general indications it would not be advisable to spend much money thereon.

The following are the analyses of the two samples selected:—

Sample No. 1, colour yellow—

	Per cent.
Fe	37·52
S	·122
P	·150

Sample No. 2, colour dark reddish brown—

	Per cent.
Fe	38·06
S	·102
P	·179

Occurrences of Bog Iron Ore at Cairnside, Quebec.

According to information received at the Office, from the party who found the deposit of iron ore at this place, the dip needle used by him indicated the existence of a magnetic field, but on testing the field very carefully in several places, I found no indication whatever of a disturbance of the earth's field occasioned by a magnetic ore deposit, the field being perfectly normal. This precluded the possibility of making a magneto-metric survey.

With the exception of limestone, which occurs two miles to the north-west of this place, Potsdam sandstone is the only rock met with for many miles. The sandstone in the region is very easily disintegrated, and in places is metamorphosed to a quartzite. According to an analysis of a representative sample, the country rock carries 0·6 per cent of metallic iron.

The reported occurrence of the iron ore, consisting of a small cone-shaped mound which I found to be bog ore, is on the line between 865 and 866 of range 4, of Jamestown, St. Malachi de Ormstown parish, Chateauguay county, Quebec, and is located in a clay bed near a small creek or rivulet.

According to Mr. Greig, who owns this property, the small deposit of bog ore (Limonite) above referred to, was thrown out of a well which was found immediately adjoining, partially filled with earth and debris. In digging to a depth of a little more than a foot in the bottom of this well, a solid bed of clay was reached, and test pits put down in several parts of this field in the vicinity of the well, revealed the same bed of clay.

An examination of the mound of bog ore showed it to be the deposit of a spring long since dried up. Another spring a few miles from this one is still actively depositing an iron oxide in the form of a cone.

Along the roads can be seen a red discoloration due to the iron oxide deposited, and the earth in several places is coloured red by this means; but no deposit of iron ore of economic importance was found, or, in fact, any indication which would point to the existence of one.

As mentioned above, the country rock is easily disintegrated, and as it contains about 1 per cent of metallic iron, it is evident that the iron carried in solution by the drainage waters and deposited along the roads and in fields has its source in the ferruginous Potsdam sandstone.

CHEMICAL LABORATORY.

SUSSEX STREET SECTION.

(F. G. Wait, M.A., F.C.S., and M. F. Connor, B.Sc.)

Dr. Eugene Haanel,
Director of Mines,
Ottawa.

Sir,—Since the laboratory of the Geological Survey was placed under the direction of the Mines Branch, of the Department of Mines, 140 specimens have been examined and reported upon.

For convenience, these may be arranged as follows:—

I. Fossil Fuels, comprising

(1) *Lignite*, 6 samples, from

(*a*) Ontario—

i. Drift, or detrital matter, consisting of a mixture of small more or less rounded particles—$\frac{3}{8}$ of an inch or less in greatest diameter—of pyrite, lignite and fossil resin, said to have been taken at a point about five miles north of New Liskeard, Ont., where a very small quantity occurs scattered through, and embedded in, the clay subsoil. This material has, not improbably, been carried, by glaciers or other agencies, from the lignite, which occurs in the area drained by the Missinaibi river.

(*b*) Alberta—

i. Tp. 52, R. 7, west of 5th meridian.
ii. Tp. 52, R. 15, west of 5th meridian—'Wolf creek.'
iii. Tp. 53, R. 7, west of 5th meridian—'Jocks Crossing,' Pincher creek.
iv. Tp. 54, R. 16, west of 5th meridian—'McLeod river.'
v. Tp. 54, west of 5th meridian.

(2) *Lignitic coal,* 4 samples, from

(*a*) Alberta—

i. Coal creek, a tributary of Prairie creek, which is an affluent of the Athabaska river—samples from a thirty inch seam, being the first exposure at Genest's first stake.
i. From an eight foot seam at the same locality.
iii. North half Sec. 28, tp. 15, R. 27, west of 4th meridian.

(*b*) British Columbia—

i. Collins gulch.

(3) *Coal.* 22 samples, from

(*a*) Nova Scotia—

i. Richmond mine—three and a half miles from Port Richmond, Richmond county.
ii. Big Marsh, Antigonish county.
aa. An average sample of the whole of the five to eight foot seam.
bb. Selected fragments from the same exposure.

I. Fossil Fuels—*Continued.*

(*b*) Alberta—
i. Brazeau river, south-east of big seam; eight feet.
ii. Brazeau river—stream between the river and McEvoy's trail.
iii. South Brazeau river—'W. Gamble' claim—six samples.
iv. South Brazeau river—'Daly' claim.
v. Bighorn river—'H. B. McGiverin' claim—three samples.
vi. Sec. 9, tp. 7, R. 3, west of 5th meridian—three samples.

(*c*) British Columbia—
i. Skeena district, Morice river, 'Dockvill' coal—three samples.
ii. Okanagan lake.

(4) *Semi-anthracite.* One sample, B.C.—locality not specified.

(5) *Anthracite.* One sample—
British Columbia—Hudson Bay mountain.

II. Iron Ores.

(*a*) Nova Scotia—
Limonite from Kingsbury, Lunenburg county.

(*b*) Ontario—
Magnetite from vicinity of Clarendon station (K. and P. R'y), Frontenac county.

III. Copper Ores.

(*a*) New Brunswick—
Vicinity of Dalhousie—Copper, metallic, 1·12 p.c.

(*b*) Quebec—
Shefford county—Metallic copper content—5·33 p.c.

IV. Brick and Pottery Clays.

(*a*) Manitoba—
i. Clay shales from LaRivière. Six samples.

(*b*) Alberta—
i. Vicinity of Medicine Hat.

(*c*) British Columbia—
i. Cascade mountain.

V. Natural Waters.

(*a*) Quebec—
i. From an artesian boring, in Ste. Cunegonde, a suburb of Montreal.

(*b*) British Columbia—
i. From a hot spring on a small island of the Queen Charlotte group.

VI. Furnace Assays for gold and silver, from

(*a*) Nova Scotia—
Three miles from James River station, Antigonish county.

(*b*) Ontario—
i. Montreal River district.
ii. Larder Lake district.

VI. FURNACE ASSAYS for gold and silver—*Continued.*

(*c*) British Columbia—

i. Hootalinqua river. Four samples of black sand obtained by washing the gravels of the river bed from the following points:—

(*a*) From a bar at Six Mile cabin, 6 miles from the mouth of the river.

(*b*) From O'Brien and Cumming's bar, about forty to forty-two miles from the river mouth.

(*c*) From a point about sixty miles up stream, and one mile below the mouth of Boswell river.

(*d*) About seventy miles up from mouth of the river.

Content, expressed in grains per cubic yard of gravel—calculated on the basis of 125 pans to the cubic yard:—

Sample.	Gold.	Silver.	Platinum.	Osmiridium.
a	98·6	20·2	2·3	trace
b	18·8	2·8	1·2	0·025
c	20·8	4·4	0·34	
d	15·6	2·4		

VII. MISCELLANEOUS.

Under this group are placed some eighty-five specimens of minerals and rocks, which were obtained in various parts of the Dominion, and required an examination, a description, or a partial analysis.

i. Of these, mention might be made of (i) a limestone from Guysboro' county, Nova Scotia, and

ii. A magnetite from a point not well defined, but situated some eighty miles west of Port Arthur, Ontario, near the line of the Canadian Northern railway.

VIII. ROCK ANALYSES.

Good progress has been made in the analyses of rock specimens, collected in

(*a*) Quebec, by J. A. Dresser, M.A.

(*b*) British Columbia, by R. W. Brock, M.A., and Dr. R. A. Daly.

In carrying out the work referred to in this summary, all that indicated under the headings 'Furnace assays' and 'Rock analyses' has been conducted by M. F. Connor, B. Sc.; whilst the remainder has been done by myself.

Respectfully submitted,

F. G. WAIT,
Chemist.

OTTAWA, March 31, 1908.

WELLINGTON STREET SECTION.

(Harold A. Leverin, M.E.)

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—The following is the report of my work since March 23, 1907.

Apart from numerous specimens sent to this laboratory for identification, 462 samples in all were received and analysed quantitatively. The larger part of these consisted of iron ores collected by the field staff: Dr. Woodman, Fritz Cirkel, M.E., and E. Lindeman, M.E. Eight complete iron ore analyses were made. Samples containing about 45 per cent and more in iron ore were generally analysed for silica, iron, sulphur, phosphorus, lime, magnesia, alumina, and titanium—if any. In sixty-five samples from diamond drill cores from Austin brook, N.B., only iron, insoluble matter, sulphur and phosphorus were determined, as the composition of the gangue had been determined the previous year. A number of samples of low grade iron ores contained less than 40 per cent iron, hence no other determinations were made in these cases.

The samples were of the following character:—

Iron ore	301	Cobalt ore	1
Gold and silver ore	38	Molybdenite	1
Chrome	32	Alloy	6
Copper	26	Limestone and dolomites	16
Iron pyrite	5	Clay	16
Nickel ore	2	Fuel	5
Platinum ore	2	Sandstone	3
Lead ore	2	Slag	2
Tin ore	2	Roasted iron pyrite	1
Antimony ore	1		
		Total	462

The number of determinations made were:—

Iron	315	Cobalt	2
Ferrous oxide	23	Tin	1
Gold	43	Antimony	1
Silver	38	Silica	94
Copper	42	Silicon	4
Manganese	6	Insoluble matter	108
Chromium	32	Sulphur	193
Titanium	29	Phosphorus	186
Lime	112	Combined water	4
Magnesia	112	Moisture (in fuel)	6
Alumina	92	Volatile matter (in fuel)	6
Nickel	4	Fixed carbon (in fuel)	6
Lead	3	Ash	6
Platinum	3	Heat value of fuel	3
Alkali	3		
			1,477

The laboratory, the installation of which was completed last spring, has been considerably improved during the year by additional valuable instruments and appliances. A complete outfit for gold and silver assaying has been installed, consisting of a muffle and a melting furnace on one iron table,—of American Gas Furnace Company's make, also a very sensitive Troemner Button Balance, and various tools. The air blast for the furnaces is supplied by a Rothwell blower.

In order to obtain suitable current for electrolytic deposition of metals, a rotary transformer was put in to charge a storage battery of six cells of 2·5 volts each. For measuring the current one low reading voltmeter and amperemeter with scales respectively 0 – 15 volts and 0 – 5 amperes were purchased. The rheostat—of the ordinary circular coil of wire and lever type, enclosed in enamelled box—has a resistance of 20 ohms.

Yours respectfully,

H. A. Leverin,
Chemist.

Ottawa, March 31, 1908.

REPORT OF A VISIT TO SOME GAS PRODUCER PLANTS IN AND AROUND NEW YORK CITY, AND TO THE UNIVERSITY OF ILLINOIS TESTING LABORATORY.

(*By B. F. Haanel, B. Sc.*)

In view of the proposed installation of an experimental fuel testing plant in connexion with the Mines Branch of the Department of Mines: and that this plant may be designed with due regard to economy, and the equipment modern in every respect, the writer visited a number of gas producer and gas engine plants in New York city and vicinity, also the testing laboratory of the University of Illinois. The metropolitan city of the United States was selected as a centre for the general investigation of existing systems, upon the advice of expert engineers and business men having special knowledge on this subject: who all agreed that, in New York the greatest number of the various types of producer plants could be seen, without entailing much travel, while the university testing laboratory inspected, was selected because it was reputed to have comparatively the best mechanical equipment for gas producer and gas engine testing; besides the additional advantage of having the State Experimental Fuel Testing Station within the university buildings.

The specific objects of this investigation were (1) to obtain accurate information with regard to the difficulties encountered in the practical operation of gas producers, and gas engines using producer gas. For this purpose, it was deemed desirable to inspect plants using bituminous, as well as those using anthracite coal—especially bituminous; since this coal has a similar mode of action in combustion, to lignite and peat: which fuels are to be mainly experimented upon in the proposed fuel testing plant, (2) to obtain reliable data concerning the practical working, and the methods of testing gas engines, including a knowledge of the latest apparatus employed for measuring the volume, quantity, and power of gas.

At the outset, several days were spent in the New York offices of the Westinghouse Machine Company—one of the largest manufacturers of gas engines and gas producers. The officers of this Company generously furnished a list of the power plants in and around New York city, using producer gas; together with a detailed description of their own system of gas engines and auxiliary equipment; and at the same time imparted valuable information with regard to notable installations by other makers, both near and far. In addition, much valuable data was given on modern methods of systematically sampling and measuring gas.

Other New York firms visited, were, the Industrial Gas Company—manufacturers of gas producers, the Rotary Meter Company, and Messrs. Eimer and Amend.

PLANTS VISITED AROUND NEW YORK CITY.

(1) Atha Tool Company, Newark, N.J.

(2) Rockland Electric Company, Hillburn, N.Y.

(3) Erie R. R. Power house, Jersey City, N.J.

(4) American Watch Case Company, Jersey City, N.J.

(5) Strobel and Crane, Newark, N.J.

Atha Tool Company, Newark, N.J.—The installation here, consists of two Loomis-Pettibone gas producers, which furnish both water-gas and producer gas: the former being used for heating; the latter for power purposes.

This producer is of the down-draft type, and consists of two cylindrical, plate iron shells, lined with fire brick, placed side by side, and connected at the tops by a fire-brick lined pipe. The tops are provided with charging holes which can be closed or opened at will. Pipes, fitted with valves, lead from the bottoms of these producers to the bottom of an economizer, which is simply a vertical, tubular boiler.

When making producer gas, the charging holes of the producers, and the valves of both pipes leading to the economizer are opened, a downward draft is then created by means of an exhauster, which draws in atmospheric air through the charging holes in the producer top, down through the fuel bed, where the oxygen in its downward course combines with the carbon of the fuel, to form carbon monoxide. This gas (CO), is drawn through the bottom of the producer into the economizer, through which it ascends, and is discharged at the top, into a scrubber, and from thence is finally drawn into a gas holder. The hot gases in passing through the economizer meet a large surface presented by the vertical tubes within the economizer shell; and the water which fills these tubes absorbs part of the sensible heat of the gas, and is vapourized, the sensible heat of the gases at the same time being much reduced.

When the fuel bed becomes incandescent, the top of the producer is closed, also one of the valves connecting the bottom of the producer with the economizer. The steam generated in the economizer is then admitted under pressure through the bottom of the producer; and in passing through the incandescent fuel, is decomposed—forming water gas.

This process of making water gas, and producer-gas respectively, is alternated at intervals of about five minutes according to the quality and quantity of gas required.

The plant was originally intended for the making of water-gas only; but recently a power plant consisting of four vertical Westinghouse gas engines, direct-connected to electric generators, was installed, having a combined capacity of 539 h.p.

The engineer in charge of the producer plant, made the statement that, twice as much producer gas was allowed to escape into the air as was required to run the entire plant. This, however, could not be verified.

The producers were fired with high grade bituminous (Pocahontas) coal. No trouble was experienced with the formation of clinkers, and poking was seldom resorted to.

In order to determine the heat value of the gas, a Junker's calorimeter was installed; but this has been discarded. The quality, and heat value of the gas is now determined by the colour of the flame of the gas generated.

No reliable figures concerning coal consumption, nor the number of hours the engine is run, could be obtained, hence no estimate of the fuel efficiency of the plant could be made But, even though data could be obtained, it would be of little value, since two kinds of gas are being made and it is quite impossible to determine the amount of gas escaping into the air.

The engines ran very smoothly, required little attention, and no trouble was observed from back firing, or premature ignition; demonstrating the fact that, the producers were furnishing a gas of uniform quality, and well suited to the engines.

Rockland Electric Company, Hillburn, N.Y.—This plant is equipped with three sets of Loomis-Pettibone producers, similar to those described above; it will be only necessary, therefore, to describe some interesting details peculiar to this installation.

While the plant was originally designed to furnish both water gas, and producer gas, for heating and power to the iron works in the vicinity, it is now used for generating producer gas only, for power purposes.

Steam is only blown into the producer to break up the formation of clinkers, and to keep the fuel bed soft; and this is said to be necessary only once a day; and sometimes, only once a week. The producers are operated by down draft entirely; the economizers taking no part in the formation of the gas.

The economizer connected with one of the producers has been stripped of its tubes, and lined with fire brick; the gases being drawn through the fuel bed into the bottom of this receiver, (formerly economizer) and thence to the scrubbers. This receiver could be dispensed with entirely; in which case the two producers would operate independently of each other: in other words would constitute two separate units. The economizer shell was left intact, and lined with fire brick in order to save as much expense as possible in making the necessary alterations. It is true this receiver tends—to a very small extent—to lower the temperature of the hot gases, and at the same time allows some of the dust in the gas to settle in the bottom.

With this new arrangement, the producers will be dependent on some external source for steam to be blown into the fuel beds in the event of clinkering badly. For this purpose, a small horizontal boiler close by, will furnish the necessary steam.

When visiting this plant, the alterations above referred to were being made; consequently, under these unusual conditions, no reliable data derived from the normal working of same could be obtained. The attendant in charge of the producer plant is confident, however, that the change will be beneficial.

The two producers which were in operation at the time of the writer's visit, were giving entire satisfaction; poking was required only occasionally, and no clinkers of large size were being formed.

The quality, and heat value of the gas—determined by means of the optical qualities of its flame—appeared to be rather lean; the heat value is, however, said to be fairly high, and gives good results when burnt in the gas engines.

It was impossible—for the reason indicated—to obtain any reliable information from the attendants as to the coal consumption, analysis of the coal, and the load upon the engines; but apparently the producers were not forced at all; in fact were under-loaded rather than over-loaded. In this case, the producer would work much cooler than when working up to full-load, or over-load. Since no moisture is being introduced—other than that contained in the air and coal—it is natural to suppose that whenever worked hard, the producers would become too hot to be operated efficiently, or else become exceedingly difficult to handle.

The cooling apparatus of this plant was not designed to cool gas as hot as would be furnished under the above conditions; the gas would, therefore, be too hot to prove effective in the gas engine. It is safe to assume that, a producer operated without the introduction of additional moisture, cannot on account of the high sensible heat of the gas, prove a successful medium for the generation of gas for power purposes.

The engine equipment consists of two, double cylinder, double acting, Westinghouse gas engines, of approximately 600 h. p. each, direct-connected to Westinghouse electric generators. This is the main equipment.

Besides these engines, there are two Westinghouse, double acting gas engines of old model, of about 300 h.p.—each direct-connected to electric generators—and one, vertical, Westinghouse gas engine of about 125 h. p., used for driving the exciter. The former engines are used when the two large units are closed down for repairs, or for other reasons; and to help out when the load becomes excessive. The entire installation has a sum total of 2,100 horse power.

While visiting this plant, the two large engines, and the smaller one driving the exciter, were running smoothly, requiring no attention for regulating air supply, etc. No premature ignitions, or back firing were noticeable, and the writer was informed that no trouble from this source was experienced.

The gas furnished by these producers seems well suited to this particular type of engine, and the load they normally carry; but, as previously mentioned, trouble might, and probably would, be occasioned when the producers were over-loaded, or even run to their full capacity; since without the use of steam, or moisture other than that contained in the fuel and air, the temperatures in the producers would become excessive, causing fusion of the coal and walls of the producers; and the formation of large, unmanageable clinkers; thus producing uneven combustion, and as a consequence, poor, lean gas. Such a plant, in the writer's opinion, could not operate efficiently under any circumstances.

ANTHRACITE PRODUCERS.

Erie Railroad Power House, Jersey City, N.J.—Two 'Wood,' pressure producers of old model, using anthracite coal, of pea size, furnish gas to the gas engines for the electric light and air compressor plant.

The two producers are automatically fed, and require the attention of only one man per shift. A small vertical boiler furnishes steam. The valve in the live steam pipe leading from the boiler to the producers, is automatically controlled by means of a rope attached to a lever on the steam valve: which passes over a pulley above the valve, thence over a pulley on the top-work of the gas-holder, the free end being attached to the moveable part of the gas holder. The end of the rope attached to the lever of the steam valve, is provided with a weight which keeps the line taut; so that any movement of the gas holder, in either an upward, or downward direction, is immediately transmitted to the steam valve. Thus the steam entering the producers is gradually shut off as the gas holder fills, and is gradually opened as the gas holder empties. By this simple device, just enough steam is admitted to furnish the required amount of gas needed to run the engines.

The gas generated is forced into the scrubbers, coolers, and gas holder, by means of the pressure of the steam.

The tops of the producers are furnished with poke holes, provided with heavy caps to prevent the escape of gas. When necessary to poke the fuel bed, in order to break up clinkers, or distribute the fuel evenly, the steam is shut off, and the caps covering the poke holes removed. During the writer's visit, this process was not resorted to, and he was told that the attendant seldom had to poke the fires.

Steam is furnished to the producers at a pressure of about 90 pounds.

The producers are not continuous in their working; for their operation has to be suspended whenever the ash pit doors—situated in all cases at the extreme bottom of the producers—are opened for the removal of the ashes.

This plant worked smoothly, requiring but little attention, and furnished gas of good quality—but there is trouble, sometimes, with back firing and premature ignition; due probably to the content of hydrogen being too high. This trouble, however, is not serious. The plant has been in operation for some years, and seems to give satisfaction.

The engine equipment consists of one, 85 h. p. Westinghouse gas engine; and two horizontal 'Otto' gas engines, of rather old type.

American Watch Case Company, Jersey City, N.J.—This installation consists of one Suction gas producer, of Industrial Gas Company type—using anthracite coal, (pea size); furnishing gas for both heating, and power. In this producer the air is drawn down through the hot fuel bed of the gas producer, thus generating producer gas by means of the suction of the gas engine piston. The operation of a suction producer is similar to that of a down-draft producer: in which the air is drawn through the producer by means of an exhauster; but the term 'suction producer' is applied only to those which employ the suction stroke of the gas engine for creating the draft through the producer.

An evaporator is a distinctive feature of the Industrial Gas Company's producer. The hot gases drawn through the fuel bed of this producer pass first through the evaporator, imparting some of their sensible heat to the water trays in its interior. These trays are so arranged, that water is continually flowing over them. In this way a certain amount of water vapour is formed, which mixes with the atmospheric air drawn over these trays, and passes into, and through the producer.

The gases, after passing through the producer, enter a scrubber, and cooler, in which the gases are cleaned, and their sensible heat further reduced.

After passing through these different apparatus, the gas is said to be very clean, and causes no trouble to valves, etc., when burnt in the gas engine.

This type of producer, is furnished with a water seal bottom, which renders its operation continuous, i.e., it is not necessary to discontinue operations when removing ashes, as is the case with all the producers previously described.

A Westinghouse vertical gas engine, using the gas from this producer, furnishes power for various purposes.

Unfortunately, this plant was not in operation at the time of my visit; and as it had been installed only a very short time, little information, or data, concerning the working could be obtained.

Strobel and Crane, Newark, N.J.—The plant here, consists of an anthracite, suction producer, of like design to that last described; except in one detail.

The capacity is about 100 horse-power, and supplies gas for a 100 h.p. Westinghouse, vertical gas engine.

Instead of a water seal bottom, this producer is furnished with a closed ash pit; thus rendering its operation intermittent. In this particular only, does this producer differ from the one last mentioned.

One attendant not only looks after the producer and gas engine, but also operates a lathe.

It is necessary to charge the producer about once every two hours; and for this purpose, a bucket holding about two hundred pounds of coal is hoisted over the feeding hopper, and emptied into it. This hopper is provided with a bell operated by a steel bar; thus preventing both the escape of gas, and admission of atmospheric air.

This producer, also that last described, are furnished with poke holes, provided with heavy caps.

Inasmuch as the writer was unable to make, or witness any tests on this, or the other producers described, the following results of a four weeks' continuous test on a 500 horse-power horizontal gas engine, Westinghouse type, and a R.D. Wood bituminous producer, installed at the plant of the American Locomotive Company, Richmond, Virginia, is added.

This test was independently made, in the interest of the Company for which it was installed; hence may be regarded as unbiased as far as the manufacturers are concerned.

DETAILS OF PLANT.

Engine.—Westinghouse double-acting horizontal type, two cylinders, 23½ inch x 33 inch, two impulses given to a crank shaft at each revolution. Total weight of gas engine, 175,000 pounds.

Producer.—R. D. Wood, Tennessee type (Bell's evaporator, Rotary tar extractor).

Guarantee—

1·92 lbs. of coal	per K.W.H.	at full load	300 K.W.		
2·10	"	"	¾	" 225	"
2·64	"	"	½	" 150	"

Producer gas to have minimum heat value of not less than 120 effective B.T.U. per cubic foot, at 62° F., and thirty inches mercury; and to be free from injurious amounts of tar, water, dust and sulphur. Gas to be supplied at not less than four inches water pressure, and at a temperature not exceeding 100° F. All gas delivered to have 70½ per cent of effective heat value of coal gasified in the producer. 70½ per cent represents the efficiency of the producer.

Measurements.

Measurements of power were taken at the switchboard in the engine-room from the Thompson Recording Wattmeter, No. 1231395, type E, 1200 amperes, 250 volts. This instrument was calibrated July 31, 1907, at the testing laboratory, Twelfth Street station, of the Virginia Passenger and Power Company.

Test.

The test extended over four consecutive weeks, six days per week.

First week under ½ load.
Second week under ¾ load.
Last two weeks under full load.

Coal.

The coal record was handled as follows:—Each wheelbarrow full of coal was weighed as it was brought down upon the producer platform, and a small sample of coal was taken from it. From the samples accumulated during the day's run, an average sample of about two quarts was taken, placed in a sealed jar, and shipped to the laboratory for analysis. The analysis of samples of coal are shown in the following table:—

Average Analysis of Coal.

B. T. U.	14703
	Per cent.
Volatile matter	22·80
Moisture	·290
Fixed carbon	72·396
Ash	4·465
Sulphur	1·001

RESULTS.

Test commenced 7 a.m., August 12, and ended at 12 noon, September 7, a period of 629 consecutive hours. Actual time operated during the test was 484 hours—223 hours was full load, 125 hours three-quarter load, and 136 hours one-half load. Total kilowatt hours produced was 119,900. Total coal consumed during operation 217,206·44 pounds. Total coal consumed during test (coal during week-end shut down added) 222,319·14 pounds. During the period of actual operation 1·811 pounds of coal burned per kilowatt hour. During the entire test, 1·885 pounds coal burned per kilowatt hour (including priming, i.e., standby coal).

GENERAL.

Tar produced at full load during 223 hours operation, 443 gallons. Ash produced during 223 hours operation at full load, 66 cubic feet. Gas engine jacket water, average rate of flow in gallons per hour during 223 hours, full load, 2990. Water condensed in gas main during 223 hours at full load, 382·25 gallons.

The engine operated during the entire test without a single shut down—except those regularly scheduled at the week-ends.

ECONOMY.

GAS ENGINE TEST RECAPITULATION.

—	Priming coal.	Production coal.	K. W. H.	Test — Lbs. coal per K. W. H.	Guarantee — Lbs. coal per K. W. H.	Load K. W.	Actual average load.	Hours actual operation.
Week Aug. 12–17 inc......		47,775	21,710	2·01	2·64	150	159·6	136
Priming Aug. 19........	1,697							
Week Aug. 19–24 inc		54,143	28,540	1·89	2·10	225	228·3	125
Priming Aug. 26........	1,769							
Week Aug. 26–31 inc......		63,691	38,460	1·66	1·92	300	307·6	125
Priming Aug. 31.... ...	146							
" Sept. 1.......	288							
" Sept. 3.... ...	491							
" Sept. 3	722							
Week Sept. 3–7 inc..	1,697	51,498	31,190	1·65	1·92	300	319·2	98
	5,113	217,206	119,900	1·81 Priming not inc. 1·86 Priming inc.			247	484

	K. W.	Hours operated.	Coal gasified.	K. W. H. produced.	Average load.	Lbs. coal per K. W. H.	Guarantee.
Full load......	300	223	115,289	69,650	312·33	1·6539	1·92
Three-quarter load....	225	125	54,142·86	28,540	228·3	1·8970	2·10
Half load...................... ..	150	136	47,774·58	21,710	159·63	2·2005	2·64

The above memorandum of test results was furnished by one of the engineers to the Westinghouse Machine Company, 10 Bridge street, New York city; and is incorporated here, for the purpose of showing the economy that may reasonably be expected when using a bituminous coal over a long period of actual operations at various loads; although the particular coal used was of a very high grade.

Rotary Meter.

A volume of gas, subject to varying pressures—such as exists in a suction gas producer plant—is very difficult to measure, except when passed into a gasometer. This it is often desirable to dispense with, for the sake of economy, or other reasons. When the gas is passed into a gasometer, any effective gas meter is capable of measuring the quantity of gas flowing from the gas holder into the engine. To take the place of a gasometer, the Rotary Meter Company have put on the market a rotary meter, coupled to an anti-pulsator, which equalizes the gas pressure before entering the meter proper.

When this meter, and anti-pulsator is used in a gas engine installation—using gas from the city main, for example—it is said that, the gas bags can be dispensed with, and in certain cases even the engine governor. As to the possibility of using such a meter in connexion with a suction gas producer plant, no definite information, or data could be obtained at the New York office of the Rotary Meter Company. They had no such meter on exhibit; but reference was given to the Canadian agents of this Company—The Economical Gas Apparatus and Construction Company, 269 Front street, East, Toronto, Ont. An expert engineer of the Westinghouse Machine Company gave it as his opinion that a rotary meter might be suitable for measuring gas in a suction producer plant.

The rotary meter takes up little room—much less than the ordinary meter, and runs for a long period with gas containing dust and tarry matter, without requiring cleaning. This meter is reputed to be an accurate machine for its purpose.

JUNKER'S GAS CALORIMETER.

In almost all commercial concerns using gas for heating or power purposes, whether producer gas, natural gas, or city gas, the Junker calorimeter is used for determining the heat value, *i.e.,* the number of calories produced per unit of volume of the gas.

The determination of the heat value of combustible gases takes place in this calorimeter by a state of permanency being established in the same: in which the heat developed from a constantly burning flame is entirely transmitted to an evenly flowing stream of water. The operation of this calorimeter is thus continuous, *i.e.,* the heat value of the gas continuously burnt in the calorimeter, can be calculated with but little trouble at any moment, or whenever desired.

Since this investigation took place, one of these calorimeters has been purchased, and will be used in connexion with the fuel testing experiments to be officially conducted in Ottawa at the plant of the Mines Branch.

University of Illinois Testing Laboratory.—This institution is equipped with a 60 h. p. Otto suction producer, and a 10 h. p. horizontal Otto gas engine, also a large Sargent, double cylinder, tandem, complete expansion engine, for making producer and gas engine tests.

Up to date the gas producer has been used only for making gas to drive the Otto engine. The large Sargent gas engine, at the time of the writer's visit, had not yet been connected up.

No tests were being made on the producer and gas engine during the writer's visit; but the head of the department of mechanical engineering, and Director of the State Experimental Fuel station, very kindly instructed his assistants to furnish all the information at their disposal concerning the testing of producers, and gas engines.

Mr. C. M. Garland, Instructor in Mechanical Engineering, kindly furnished the following forms for the making of a producer and gas engine test:—

Form for Gas Engine Test.

Data and results of test of. . . . . .gas engine.
By. . . . .
Object of test. . . . .

Dimensions of Engine.

Rated h. p. at. . . . .
Diameter of piston. . . . .
Area of piston. . . . .
Length of stroke. . . . .
Piston displacement. . . . .
Clearance. . . . .
Diameter piston rod. . . . .
Diameter crank pin. . . . .
Scale of indicator spring. . . . .
Length of brake arm. . . . .
Duration of trial, hrs. . . . .
Brake load, lbs. . . . .
Gas, total cubic feet. . . . .
Gas, cu. ft. per hr. at 32° F. and 14·7 lbs. (by meter).
Air, total cubic feet. . . . .
Air, per hr. cu. ft. at 32° F. and 14·7 lbs. . . . .

Ratio air to gas by weight. . . . .
Jacket water, total lbs. . . . .
" per hr. lbs. . . . .
" temperature entering. . . . .
" temperature leaving. . . . .
Exhaust gas. Temperature. . . . .
Room temperature. . . . .
Revolutions, total. . . . .
" per hour. . . . .
" per minute. . . . .
Explosions, total. . . . .
" per hour. . . . .
" per minute. . . . .
Gas weight of a cu. ft. (Determined from volume and analysis; or by weighing).
Air weight of a cu. ft.
Mixture weight of a cu. ft.
Specific heat, gas (calculated from specific heat of different components as given by analysis).
Specific heat of air. . . . .

Specific heat exhaust gas (calculated as above, from analysis), B.T.U. of gas per cubic foot at 32° F. and 14·7 pounds.

Results.

Maximum pressure, pounds per square inch. . . . .
Compression, pounds per square inch. . . . .
M.E.P. forward stroke. . . . .
M.E.P. compression stroke (determined by special test or from the regular indicator card).
I.H.P. . . . .
B.H.P. . . . .
Friction H.P. . . . .
Mechanical efficiency . . . .
Weight of gas per hour, pounds. . . . .
" air " " . . . .
Gas per I.H.P. Hr. at 32°, and 14·7 pounds cubic foot. . . . .
" " pounds. . . . .
" B.H.P. Hr. " " cubic foot. . . . .
" " pounds. . . . .
B.T.U. in gas . . . .
B.T.U.'s supplied per hour. . . . .
" absorbed by jacket = weight × rise in temperature.
" " " per cent. . . . .
" " exhaust = weight × specific heat × rise in temperature + B.T.U. in mixture present + B.T.U. in unburned Co. and H.
" in exhaust, per cent. . . . .
" per I.H.P. . . . .
" " I.H.P., per cent. . . . .
" " B.H.P. . . . .
" " B.H.P., per cent. . . . .
" absorbed in friction . . . .
" lost by radiation, etc., (determined by differences). . . . .
" " per cent . . . .
" per I.H.P. Hr. . . . .
" " B.H.P. Hr. . . . .

Thermal efficiency from I.H.P..............................
" " B.H.P. ....

FORM FOR GAS PRODUCER TEST.

Data to be taken.

1. Weight of coal fired.
2. Weight of water used or evaporated from boiler or economizer.
3. Weight of ash.
4. Ultimate analysis of coal and heating value. Analysis of ash.
5. Cubic feet of air supplied.
6. Cubic feet of gas given off.
7. Analysis of gases given off.
8. Determination of the heating value of the gases.
9. Determination of the moisture in the gases.
10. Determination of tar and dust in the gases.
11. Temperature of room.
12. Temperature of gases leaving producer.
13. Temperature of gases leaving scrubber.
14. Weight of scrubber water used.
15. Temperature of scrubber water entering.
16. Temperature of scrubber water leaving.

Principal Quantities to be Calculated.

(*a*) Dimensions of producer.
(*b*) Coal per hour.
(*c*) Coal per square foot of grate surface per hour.
(*d*) Steam or water used per pound of coal.
(*e*) Cubic feet of air supplied per pound of coal.
(*f*) Weight of air supplied per pound of coal.
(*g*) Cubic feet of gas given off per pound of coal.
(*h*) Heating value of the gas per cubic foot.
(*i*) Total heat in coal.
(*j*) Total heat in gas.
(*k*) Efficiency of producer $= \frac{\text{Heat in gas}}{\text{Heat supplied by coal.}}$
(*l*) Heat lost in scrubber.
(*m*) Heat lost in Co_2 in gas.
(*n*) Unaccounted for loss.

In the foregoing form, the water is supposed to be vapourized by the sensible heat of the gases passing through the economizer, or vapourizer; but if this vapour is supplied from some independent source, the coal consumed in vapourizing the water passing into the producer, must enter into the calculation, as part of the total coal consumed.

Also, if the down draft is created by means of an exhauster, driven by a motor, or other power, independently of the heat produced by the coal consumed in the producer, then, the coal equivalent of the energy absorbed in doing this work must be added to the total coal consumed, and the coal equivalent of the energy absorbed in pumping and forcing the water through the scrubbers and coolers, must be added to the total coal consumed in the producer.

The head of the Department of Applied Chemistry, Professor S. W. Parr, explained the methods in vogue at the Illinois State Experimental Fuel station, of collecting samples of fuel for analysis, and gave the writer the opportunity of observing the determinations of the calorific value of many samples of coal, both by the Atwater Bomb calorimeter and the Parr Standard calorimeter.

The samples of coal are obtained at the mines from the surface of car lots ready for shipment, in amounts varying from 40 to 50 pounds, and shipped in sacks to the laboratory.

Immediately upon receipt of the material, it is reduced by quartering in the usual manner. A chuck sample, buckwheat size, is taken, and another part is ground to pass through a 100-mesh sieve, and sealed in a 'lightning' fruit jar.

In cases where time is an important factor in the determination of the calorific value of fuels, the Parr calorimeter is specially suited, because it is very easy to manipulate, and is independent of external sources of oxygen. The oxygen required for the complete combustion of the coal is derived from sodium peroxide, united with the sample of fuel. The sample of fuel, and the sodium peroxide, are placed in the bomb, and mixed together by shaking.

The determinations by this calorimeter are said to check within 50 to 60 units with those of the Atwater Bomb calorimeter, which is sufficiently accurate for almost all classes of work, except where extreme requirement is desired.

While it was not the purpose of the writer to inspect experimental plants in order to collect data on the behaviour of fuels when burned under a boiler; nevertheless, the interpolation of a few notes made on this branch of the testing laboratory of the University of Illinois may be of some value.

The equipment for making boiler tests, with different kinds of fuels, and the arrangement of apparatus, etc., is excellent.

The boiler plant is a very large one, and consists of boilers of the most approved design. Most of these steam generators are equipped with automatic stoking devices, with which, highly successful results have been achieved.

The problem of abating the smoke nuisance, has been studied here, and the experiments in this direction have demonstrated the fact that, by proper stoking the dense clouds of smoke issuing from the boiler stacks can be very materially decreased, and in most cases entirely avoided.

The boilers are admirably arranged for the taking of samples of flue gas, etc. And, as the laboratory for the analysis of these samples is placed on a balcony, or suspended floor, situated very near the boilers, the gas samples can be drawn therefrom, directly, by means of a system of piping connecting the boiler to the laboratory.

Much excellent work has been done by this Institution along the lines of improving the efficiency of the steam generator, and steam engine, but as yet, very little has been done in the direction of improving the gas producer, and gas engine.

Now that the available coal supply—once looked upon as inexhaustible—is rapidly decreasing, the interest of the State governments in the United States, possessing fuel deposits of some kind, has been awakened to the necessity of discovering more economical methods in the use of fuel; and many of these States are already considering the advisability of establishing experimental fuel testing stations, whose function it will be, to determine by experimentation, the most effective methods of converting the potential energy stored in the different natural fuels, into useful work.

Seeing that wood cannot now be considered a source of fuel; and that the anthracite coal deposits of the United States will probably be exhausted in about fifty years; while the bituminous deposits in North America are being rapidly depleted, the importance of conducting experiments for the purpose of discovering a substitute for, or of decreasing the extravagant waste of, our fuel resources, cannot be overestimated.

REPORT ON THE WORK OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

(John McLeish, B.A.)

This Division was transferred from the Geological Survey Branch to the Mines Branch on June 19, 1907. Its functions are described in paragraph (*a*), section 6, of 'The Geology and Mines Act,' of 1907, viz., 'to collect and publish full statistics of the mineral production, and of the mining and metallurgical industries of Canada, and such data regarding the economic minerals of Canada as relate to the processes and activities connected with their utilization, and to collect and preserve all available records of mines and mining works in Canada.'

Formerly, part of the work specified above, had been undertaken in the Geological Survey, by the Division of Mineral Statistics and Mines—known latterly, as the Mines section. This section was organized in 1886, and its duties were described in paragraph (*d*), section 5, of the Acts respecting the Department of the Geological Survey.

The routine work of the Division during 1907 has been carried on much as usual, though under some difficulties; due (1) to the absence on sick leave for six months in the early part of the year of Mr. Ingall, Mining Engineer to the Geological Survey, in charge of the Mines section; (2) to the temporary disorganization caused by the transfer of the records, files, and general equipment of the Division, from the Museum building on Sussex street, to the Thistle building on Wellington street; and generally the reduction in the numerical strength of the staff; Mr. Ingall having remained as a field officer in the Geological Survey.

In January, blank forms for statistical returns, were, in accordance with the usual custom, sent out to mining companies throughout Canada, and by March 1, sufficient information had been received to compile the summary of the mineral production in Canada, in 1906—subject to revision; which was at once printed, and distributed. In connexion with the early publication of this preliminary report, acknowledgments are due to the various provincial mining Bureaus for their hearty co-operation in furnishing estimates of the mineral production in the several provinces; also to several of the railway corporations, for furnishing statements of the shipments of ores from stations on their lines. Although the figures of output are subject to some variation in the final report—necessarily published much later in the year, the early publication of the material in this form is very useful; since the statistics, and general résumé of the mining progress given, furnish a fairly approximate estimate of the mineral output during the year.

Previous to the publication of this preliminary report, there was completed, and distributed on February 24,—to those immediately interested—a statement covering the production, sales and imports, etc., of Portland cement during 1906, and previous years. This statement was very favourably received by the cement manufacturers, and others; and a similar method of procedure might with great advantage be followed in other lines of the mineral industry. Comparative promptness on the part of mining operators, however, is essential to success in this class of work; as it can easily be seen that one or two delinquent correspondents may easily delay for days or weeks the issue of a whole report

It is the desire, and object of the Department, not only to furnish the public with the means of obtaining a broad knowledge of Canada's mining industries and resources and to supply information that shall attract and assist the investment of capital in the development of these resources; but also, to be of as great service as possible to those directly interested in our mining industries.

The annual report of the Mines section for the year 1905, was completed and sent to the printer on or about the 14th of January. The proofs were corrected and revised by the officers of the section, and the completed report distributed about the 29th of July.

The decrease in the strength of the staff, as a result of the transfer of the work from the Geological Survey—where it consisted of three technical officers and two clerks—has contributed to the delay in the compilation of the final report on the mineral industries of Canada during 1906. The material, however, is well in hand, and should shortly be ready for publication.

In addition to the collection and compilation of mining statistics, and the preparation of the annual reports, the attention of the staff is required in several important directions: such as keeping up-to-date, a general index of mineral occurrences; selecting and clipping from the mining and general press information pertaining to mining development, and filing the same for convenient reference. The Division is also called upon to furnish information, in reply to inquiries, on all kinds of technical matters pertaining to the mineral deposits and mineral industries of the country. These are often so extended in their scope as to require considerable time for their preparation. Amongst the minerals, or ores which have been particularly sought during the year, may be mentioned the following: titanium ore, arsenical pyrites, garnets, gypsum, magnesite, rubies, rutile, talc, dolomite, marbles, granite, refractory clays, etc.

No field work has been undertaken by officers of the Division, in its behalf, during 1907.

The mining industry has shown a very large growth during the past ten years: the value of the output having increased from a little over twenty-two million dollars in 1896, to almost eighty million dollars in 1906, and the Department is being constantly called upon year after year, to furnish greater information concerning every feature of this development.

In view of the organization of the Department of Mines, with a Mines Branch devoted particularly to economic work, and the transfer to this Branch from the Geological Survey of the work of this Division, it would, perhaps, be advisable to record here, something of what has been done in the past in this line of work, and to point out the direction in which it may be improved, and made of much greater value to the public.

In the past, the appropriation available, and the strength of the staff, were never sufficient to enable the officers in charge of the Division, to properly carry out the functions devolving upon them; and while probably the best was done which the means at hand, and the difficulties of the situation would permit, a great deal more should be accomplished, and it now devolves upon the reorganized branch to inaugurate a much more vigorous policy of action in order to increase the efficiency of the work already begun, and to extend its scope, necessitated by the growth and expansion of the mining industry.

The Division of Mineral Statistics and Mines of the Geological Survey was organized in 1886, and annual statistical reports of the mineral industries of Canada have been issued by the Division since that time. These reports furnished not only statistics of mineral production of the year under consideration; but annually repeated in tabular form the statistics collected during the previous years; for the purpose of showing the growth of the industries. The reports also contain all available information as to exports and imports of minerals and ores, and metallurgical products. These reports, moreover, usually included information concerning mining development in some of the important mining centres throughout Canada, as well as information as to markets and prices when such was available: together with lists of producers of some of the important mineral products.

The work of the Division may be described in greater detail as follows:—

THE COLLECTION OF STATISTICS.

Lists of producers are prepared each year, and circulars sent out to those requesting a return of their mineral production. If necessary, the request is repeated by additional circular letters or telegrams.

When important producers still remain unheard from, a personal application by a special agent would be advisable. As an exception to the above general method, it should be explained that statistics of coal, and gold production in Nova Scotia, are obtained by agreement through the Provincial Department of Mines, and statistics of the production of metallic ores in British Columbia are obtained through the courtesy of the Provincial Mineralogist of that province.

A proposal has been made, though not yet carried into effect, for co-operation with the Mining Bureau of the Province of Ontario in the collecting of mining statistics of that province.*

It might be well here to refer to the fact that, each of the provinces in Canada, with the exception of Prince Edward Island, and New Brunswick, provides for the collection and publication of statistics of mineral production, more or less complete. With the exception of that already mentioned, there is as yet, no co-operation between any of these provinces and the Dominion government in the matter of collecting and publishing these statistics. Such different styles of questions are asked, covering different years, that the figures of production published by the provinces seldom agree with those compiled in this Division; hence, while each may be approximately correct from its own particular point of view, the result is somewhat disconcerting to the inquirer who consults the differing reports.

It is, therefore, greatly to be desired that, methods should be devised, if possible, whereby these reports might be made more uniform in their statistical contents, besides avoiding the unnecessary duplication of effort in the collection of the material.

The statistical information contained in the reports of this Division, while probably as complete for some minerals, or mineral products, as it is possible to obtain such information at the present time, and under present conditions, is nevertheless for other products, open to considerable improvement.

More detailed records of metallurgical products, such as iron, and steel, etc., might with advantage be obtained and published; while statistics of the production of some of the structural materials, such as the clay products, lime, and the output of stone quarries, etc., might now be secured with greater completeness. The earlier attempts to obtain statistics of these products, met with indifferent success; owing partly to the wide-spread distribution of the industries over a large extent of territory, and to the large numbers of those who operated on a very small scale, and who in many cases either would not, or could not, furnish the information desired. Conditions, however, have greatly changed. These industries are now being concentrated into larger units, and our efforts to obtain returns during the past year or two, have met with much more encouraging success.

Much improvement might also be made by the addition of statistics of production in foreign countries so as to show the world's consumption and the sources of supply. The use of graphic tables for exhibiting products, exports, imports, prices, etc., might also be considerably extended. Information as to prices paid by smelters, for metallic ores, should be published whenever available, and in many other ways the reports might be made of greater value to the mining public.

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* (See Summary Report of the Geological Survey Department for 1906, page 7.)

INDEX TO MINERAL OCCURRENCES.

This comprises a card index system of references to Canadian mineral occurrences contained in the reports of the Dominion Department of Mines; the various provincial mines reports, and the proceedings of mining and geological societies. This index is arranged under the headings of the metals, and non-metallic minerals of economic importance.

As a considerable amount of mining and geological literature is annually published, a good deal of time is required to keep the index up-to-date; but it forms a very useful and valuable list of economic mineral occurrences, as well as references to the sources from which information concerning them can be secured.

MINERAL OCCURRENCE RECORD FILES.

This is an amplification of the card index mentioned above, and arranged in the same general order. Instead of references, however, it is designed to contain actual records of mining development obtained from all sources, such as through correspondence, field investigations, etc., and clippings from the mining press. It is a convenient method also for the filing of mining plans, annual reports of mining companies, photographic prints, etc., in fact, all classes of records pertaining to mining work.

Unfortunately, the lack of systematic field work in the past has resulted in the information available, being far from complete. This condition will, no doubt, be largely remedied by the field work now being done under the direction of the Mines Branch in connexion with the collection of information about Canadian mines. But in the future, to keep such records up-to-date, will require regular periodical field investigation.

CLIPPING SYSTEM FOR MINING INFORMATION.

Copies of most of the mining papers published in Canada, as well as a selection from the general press, are received, and carefully scanned; clippings being made of all interesting material referring to mining subjects. The information obtained in this way, serves to keep the Division informed as to the trend of mining development throughout the country; particularly in districts not visited by officers of the Department. As the inauguration of new industries is usually recorded in the press in some way or other, the clipping system presents an additional and important means of keeping our lists of mining operators up-to-date. All information obtained through the clipping system, which appears to be authentic, and of future value, is subsequently filed with the mineral occurrence records.

This source of information might be greatly extended, and improved, by increasing the number of papers under review, and devoting more time to the classification of the material gathered than we are now able to do.

In conclusion, it may be said that, while the necessity for regular field work in order to 'collect and preserve all available records of mines and mining works in Canada' has already been pointed out, personal visits to mining localities, and mining operators, are also necessary in order that officers of the Division may secure the essential details of production, mining costs, markets, etc., which are so necessary to a proper understanding of statistics. At best the information secured by means of circulars, and correspondence, is general and superficial, and should be supplemented by field inquiry.

The number of officers whose time should be devoted to collection of information in the field, will depend to a large extent on the amount of detail it is considered necessary to secure, as well as on the amount of appropriation to be devoted to the purpose. The different mineral industries could be apportioned amongst the staff as follows: one man might devote his attention to the metallic ores and metallurgical industries; a second to the fuels and other non-metallic minerals, such as asbestos, gypsum, salt, abrasives, etc., while a third could keep informed concerning the structural material industries, such as the clay products of all kinds, building and other stone, the cement industries, etc. Structural materials form an extremely important class of mineral products in a growing country like Canada, and are deserving of great attention. As the strength of the staff increased, the work could be further subdivided; the work of each officer on a specific subject, being limited in extent; but increased in the detail of its investigation.

With respect to the office work, an immediate increase in the clerical staff is necessary if the work at present undertaken is to be efficiently carried on; and when systematic field work is undertaken, additional clerical assistance will undoubtedly be required in connexion therewith.

Our new office quarters are much better lighted, and better furnished than the old; but somewhat smaller in actual floor space, so that we are still rather cramped for room.

JOHN MCLEISH.

OTTAWA, March 27, 1908.

II.—STATISTICAL REPORT.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

March 27, 1908.

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—I beg to submit herewith the annual preliminary report on the mineral production of Canada in 1907.

The figures of production given are, of necessity, subject to revision, since at this time, in many instances, producers of metallic ores have not themselves received complete returns from smelters. For these and other reasons, estimates have to be made. It is hoped, however, that this preliminary statement may serve to give a general idea of the gross output of the mineral industry during the year.

When more complete information is available, the annual report will be prepared. It will contain the final statistics in greater detail, as well as information relating to exploration, development, prices, markets, imports and exports, etc.

Acknowledgments are due to the various operators who have promptly furnished statements of their production, to the Provincial Mineralogist of British Columbia for a complete preliminary statement of mineral production in that province, and to the other provincial mining bureaus for assistance kindly rendered.

I am, sir, your obedient servant,

JOHN McLEISH.

Preliminary Report on the Mineral Production of Canada in 1907.

(Subject to revision.)

Product.		Quantity. (a)	Value. (b)
METALLIC.			$
Antimony ore	Tons.	2,016	65,000
Copper	Lbs.	57,381,746	11,478,614
Gold—Yukon $3,150,000			
" All other 5,114,765			
		....	8,264,765
Iron ore (exports) (c)	Tons.	25,901	45,907
Pig iron from Canadian ore (d)	"	107,599	1,982,307
Lead (e)	Lbs.	47,565,000	2,532,836
Nickel (f)	"	21,189,793	9,535,407
Silver (g)	Oz.	12,750,044	8,329,221
Cobalt, zinc, and other metallic products		....	200,000
Total metallic		....	42,434,087
NON-METALLIC.			$
Arsenic (refined)	Lbs.	660,080	36,210
Asbestos	Short tons.	62,018	2,482,984
Asbestic	"	28,519	22,059
Chromite	"	7,196	72,901
Coal	"	10,510,961	24,560,238
Peat	"	50	200
Corundum	"	1,892	177,922
Feldspar	"	12,584	29,809
Graphite	"	579	16,000
Grindstones	"	5,382	46,876
Gypsum	"	475,508	642,470
Limestone for flux in iron furnaces	"	359,503	298,097
Mica	"	....	333,022
Mineral Pigments—Barytes	"	2,016	4,500
" " Ochres	"	5,828	35,570
Mineral water	Galls.	250,985	110,524
Natural gas (h)		....	748,581
Petroleum (i)	Bls.	788,872	1,057,088
Phosphate	Tons.	750	5,514
Pyrites	"	39,133	189,353
Salt	"	72,697	342,315
Talc	"	1,534	4,602
Tripolite	"	30	225
Total		....	31,217,060

(a) Quantity of product sold or shipped.

(b) The metals, copper, lead, nickel and silver, are, for statistical and comparative purposes, valued at the final average value of the refined metal in New York. Pig iron is valued at the furnace, and non-metallic products at the mine or point of shipment.

(c) Copper contents of ore, matte, etc., at 20·004 cents per pound.

(d) The total production of pig iron in Canada in 1907 was 651,962 short tons, valued at $9,125,226, of which it is estimated about 107,599 tons valued at $1,982,307 should be attributed to Canadian ore, and 544,363 tons, valued at $7,142,919 to the ore imported.

(e) Lead contents of ore matte, etc., at 5·325 cents per lb.

(f) Nickel contents of matte shipped at 45 cents per lb.

(g) Silver contents of ore, etc., at 65·327 cents per lb.

(h) Gross return from sale of gas. Additional returns increase this item to $803,908.

(i) Deduced from the amount paid in bounties and valued at $1.34 per barrel.

(Subject to revision.)

Production.	Quantity. (a)	Value. (b)
STRUCTURAL MATERIALS AND CLAY PRODUCTS.		$
Cement—natural rock .... Bls.	5,775	4,043
" Portland .... "	2,368,593	3,374,428
Flagstones .... Sq. yds.	3,000	2,550
Sands and gravels (exports) .... Tons.	298,095	119,853
Sewer pipe	......	1,211,000
Slate .... Squares.	4,335	20,056
Building material, including bricks, building stone, lime, etc., estimated on the basis of production in 1906	....	7,500,000
Total structural materials and clay products	....	12,232,330
Total all other non-metallic	....	31,217,060
Total non-metallic	....	43,449,390
Total metallic	....	42,434,087
Estimated value of mineral products not returned	....	300,000
Total, 1907	....	86,183,477

ANNUAL PRODUCTION SINCE 1886.

1886	10,221,255	1897	28,485,023
1887	10,321,331	1898	38,412,431
1888	12,518,894	1899	49,234,005
1889	14,013,113	1900	64,420,983
1890	16,763,353	1901	65,804,611
1891	18,976,616	1902	63,211,634
1892	16,623,415	1903	61,740,513
1893	20,035,082	1904	60,073,897
1894	19,931,158	1905	69,525,170
1895	20,505,917	1906	79,057,308
1896	22,474,256	1907	86,183,477

REMARKS.

The early months of 1907, and even well along past the middle of the year, was a period specially marked by great activity in all branches of commerce, and the mining industry shared with other commercial undertakings the beneficial results of increasing prosperity. The outlook was, for a mineral production, far beyond all previous records. But excessive prosperity brought about its own depression, since within a few months of the close of the year, a rapid change took place. Whereas before, the transportation companies were unable to take care of the business offering, work was so plentiful that labour became scarce and high in price, the demand for commodities so great, that in the case of the metals, prices rose to figures seldom before reached; in one short month exactly the reverse conditions were in evidence; railway cars became idle for want of freight, labouring men were glad to accept reductions in pay and keep their jobs, and the prices of the metals fell with rapidity. Fortunately, however, for us in Canada, the financial stringency has not had such serious results as with our friends across the border, and although in some of the mineral industries it was found necessary to cease operations, some of these have already resumed, and the great mass of the mining industry still continues to enjoy a conservative and steady progress. Fortunately this change of conditions occurred too late in the year to seriously affect the expected increase in mineral output. Thus it is that we are enabled to record a substantial increase of over nine per cent in the mineral production in 1907 as compared with 1906. The total value of the output, valued according to the methods adopted in this branch since its inception, was about $86,183,477, the largest output the Canadian mining industry has yet attained.

As might be expected, however, increases in production are not shown uniformly throughout all the mining industries.

There are some decreases to record, such for instance as in gold and lead, and in a number of products of lesser relative importance, such as corundum, feldspar, graphite, etc., but these are more than counterbalanced by the large increases in pig iron, silver, asbestos, coal, natural gas, petroleum and Portland cement.

The two following tables will illustrate these features more explicity, the first showing the total increases or decreases in value of some of the more important products, and the second, the percentage increase or decrease in quantity as well as in value.

Product.	Increase.	Decrease.
	$	$
Copper	758,170	
Gold, Yukon		2,450,000
Gold, all other		780,436
Pig iron, (from Canadian ore)	257,907	
Lead		556,351
Nickel	586,573	
Silver	2,669,766	
Other metallic products	137,930	
Asbestos	444,900	
Chromite		18,958
Coal	4,828,219	
Corundum		27,051
Gypsum		824
Natural gas	182,160	
Petroleum	295,328	
Portland cement	210,021	
Other net increases	588,815	
	10,959,789	3,833,620
Total increase	7,126,169	

Product.	Quantity.		Value.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic—				
Copper	3·18		7·07	
Gold				28·10
Pig iron (from Canadian ore only)	2·79		14·95	
Pig iron (from both home and imported ore	8·94		16·64	
Lead		12·89		18·01
Nickel		1·40	6·55	
Silver	56·47		47·17	
Non-metallic—				
Asbestos and asbestic	10·16		21·59	
Coal	7·66		24·47	
Corundum		16·79		13·19
Feldspar		25·75		27·10
Gypsum	13·55			·13
Natural gas			31·21	
Petroleum	38·45		38·77	
Portland cement	11·74		6·63	

It will be observed that a slight increase is shown in copper output, a decrease in British Columbia being more than offset by an increase in the copper contents of the Sudbury nickel-copper ores. A very large decrease in gold production—over 28 per cent—practically represents a falling off in every district, with the possible exception of Nova Scotia.

In pig iron production, a substantial increase is indicated. New furnaces were in operation at Hamilton and Port Arthur. The production of lead was less by about 13 per cent. Nickel shows but little change. The output of silver was over 50 per cent greater than in 1906, and this despite a falling off in British Columbia, the large increase being entirely due to the shipments from the Cobalt district.

Amongst the non-metallic products, the asbestos industry shows substantial progress, an increase of 10 per cent in quantity, with higher prices. Coal mining also shows a steady growth in all fields, with higher prices realized. Natural gas and petroleum production also show large increases, and this is particularly gratifying as indicating that these fields in Ontario have not yet reached the exhaustion point. Portland cement, with incomplete returns, shows an increase of nearly 12 per cent.

It becomes interesting at times to compare the relative importance of the various industries in respect of their total values, and the following table has been compiled to show for the years 1907 and 1906, the position in the scale of importance of a number of mineral products, constituting together about 95 per cent of the total.

1906.		1907.	
Products.	—	Products.	—
1. Coal	24·93	1. Coal	28·498
2. Gold	15·03	2. Copper	13·318
3. Copper	13·74	3. Nickel	11·064
4. Nickel	11·19	4. Silver	9·664
5. Brick, stone, and lime	8·00	5. Gold	9·589
6. Silver	7·15	6. Brick, stone, and lime	8·702
7. Cement	3·96	7. Cement	3·915
8. Lead	3·83	8. Lead	2·938
9. Asbestos	2·49	9. Asbestos	2·906
10. Pig iron (from Canadian ore)	2·16	10. Pig iron (from Canadian ore)	2·300
11. Petroleum	·95	11. Petroleum	1·226
12. Gypsum	·74	12. Natural gas	·888
		13. Gypsum	·745

Gold.—Four years ago gold was relatively the most valuable mineral product in Canada, but in 1907 it has fallen to fifth place. A continual shrinkage has taken place in the output of the Yukon from $22,275,000 in 1900, to about $3,150,000 in 1907. The effect of this shrinkage was to some extent lessened by the continued increase from British Columbia, but in 1907 this province also shows a falling off both in placer and lode output, a decrease of over 13 per cent. Less than half as much gold was obtained from the Yukon in 1907 as in 1906. Of the total gold output in 1907, about 47 per cent was obtained from placer and hydraulic workings, and 53 per cent from sulphuret and quartz ores.

Silver.—About 12,750,044 ounces of silver were contained in ore shipments in 1907 as compared with 8,473,379 ounces in 1906, an increase of over 50 per cent. Over 99 per cent of the production in 1907 was derived from the provinces of Ontario and British Columbia, and about 77 per cent from the Cobalt district of Ontario alone.

The price of refined silver varied considerably during the year. The average monthly price reached its highest in February, at 68·835 cents per ounce, falling slightly in April and May, and increasing to over 68 cents again in July and August, but falling rapidly during the balance of the year to an average of 54·565 cents in December. The average of the year was 65·327 cents as compared with an average of 66·791 cents in 1906.

The rapid development of the Cobalt district has brought the province of Ontario to the front as a silver producer, and although complete returns have not yet been received from the smelters, close estimates have been made by the mine owners. Returns from 24 shipping mines show the ore shipped as approximately 14,557 tons, containing 9,914,056 ounces of silver. At the average price of refined silver, for the year, this would be worth $6,476,555 and it represents an average return of 681 ounces of silver, or $444.87 per ton of ore shipped.

There was a slightly smaller output of silver in British Columbia in 1907, a falling off of probably about 200,000 ounces.

It may be noted that there was a larger amount of silver in ore, etc., entered for export than the records of production show, the excess being over 2,000,000 ounces. The exports for the 12 months, according to the Customs Department returns, were 14,813,735 ounces valued at $9,941,849, an average value per ounce of 67·11 cents.

Copper.—The aggregate production of copper, 1907, was about 57,381,746 pounds, an increase of 3 per cent over 1906.

The copper mines of the Boundary district of British Columbia, as well as others in the Nelson and Coast districts, were closed down in November, and although some of them resumed again after a few weeks, the total output for the province was somewhat less than in 1906. This decrease, however, has been more than met by the increased output of copper from the Sudbury ores of Ontario (see under nickel). Of the total production in 1907, over 72 per cent was obtained from British Columbia mines, and 19 per cent from Ontario.

The price of copper varied greatly during the year. In March the average monthly price of electrolytic copper in New York was 25·065 cents per pound. In July this had fallen to 21·130 cents, and to 13·169 cents in October. The average for the year was 20·004 cents, as compared with 19·278 cents in 1906.

The total exports of copper in ore matte and other forms were, according to Customs Department returns, 27,194 tons.

Lead.—All the production recorded was mined in the province of British Columbia. The output is less than that obtained in 1906 by nearly 13 per cent. A considerably less tonnage was shipped from East Kootenay mines, with probably an increased output from West Kootenay.

No bounty was paid during 1907 on lead ore, but in December the price of lead had fallen to a point at which bounty could be claimed.

The exports of lead in ore, etc., during the year were 10,989 tons, and of pig lead, etc., 1,807 tons, or a total of 12,796 tons.

As with the metals, silver and copper, the price of lead also fluctuated widely during the year. In New York, for the first five months of the year, the prices held steadily at 6 cents per pound, then steadily decreased, the average for December being 3·658 cents, and the average for the year 5·325 cents, as compared with 5·657 cents in 1906.

On the London market the highest quotation during the year was £22 2s. 6d., and the lowest £13 per long ton, a difference between highest and lowest of over £9.

Nickel.—With the exception of the nickel contained in the ores shipped from the Cobalt district, the production of nickel in Canada is derived entirely from the well-known nickel-copper deposits of the Sudbury district. The output has been increasing steadily for a number of years, although the actual amount of nickel contained in matte shipped in 1907 is somewhat less than in 1906. Two companies are carrying on active operations: The Mond Nickel Co., at Victoria Mines, and the Canadian Copper Co., at Copper Cliff. The ore is first roasted and then smelted to a Bessemer matte containing from 77 to 80 per cent of the combined metals, copper and nickel, which is shipped to the United States and Great Britain for refining.

The following were the aggregate results of the operations on the nickel-copper deposits of Ontario in 1906 and 1907:—

—	1906.	1907.
	Tons of 2,000 lbs.	Tons of 2,000 lbs.
Ore mined	343,814	351,916
Ore smelted	340,059	359,076
Bessemer matte produced	20,364	22,041
" " shipped	20,310	22,025
Copper contents of matte shipped	5,265	6,996
Nickel contents of matte shipped	10,745	10,095
Spot value of matte shipped	$ 4,628,011	$ 3,289,382
Wages paid	1,117,420	1,278,694
Men employed ....Number.	1,417	1,660

According to Customs returns, exports of nickel in matte, etc., were for twelve months ending December 31, as follows:—

—	1906.	1907.
	Pounds.	Pounds.
To Great Britain	2,716,892	2,518,338
To United States	17,936,953	16,857,997
	20,653,845	19,376,335

The price of refined nickel, according to the *Engineering and Mining Journal*, of New York, remained fairly steady throughout the year. The uniform weekly statement being that 'for large lots, New York, the chief producer quotes 45 to 50 cents per pound, according to size and terms of order. For small quantities 50 to 65 cents, same delivery.'

It will be noted, however, in the above statistics of production, that the matte shipped in 1907 is valued at a much lower rate than in 1906, although the average prices of both copper and nickel, according to quotations, were slightly higher in 1907.

The above figures of nickel production do not include the nickel contents of the silver-cobalt ores from Cobalt district, complete statistics of which have not been obtained by this Department. The shippers of silver-cobalt ores receive practically no returns for the nickel contents, although these amounted in 1906 to about 3 per cent of the ore shipped, according to returns published by the Ontario Bureau of Mines.

Zinc.—No official statistics regarding zinc ore production in British Columbia are to hand, and the zinc smelter at Frank, Alta., has not been in operation during the year. A few tons of zinc ore were mined in Ontario.

Iron Ore.—The total shipments of iron ore from mines in Canada, in 1907, were 310,996 short tons, valued at the mine at $662,441, as compared with 248,831 tons, valued at $589,206 in 1906. Of the total shipments in 1907 there was shipped to destinations in Canada 283,543 tons, and to the United States 27,453 tons.

Pig Iron.—The total production of pig iron in Canada in 1907, from both Canadian and imported ores, according to direct returns from nine companies operating

16 furnaces, was 651,962 short tons, valued at $9,125,226, an increase of nearly 9 per cent in quantity over the amount made in 1906. These figures do not include ferro-products made in electric furnaces. Of the total output of pig iron last year 10,047 tons were made with charcoal as fuel, and 641,915 tons with coke.

The amount of Canadian ore, including mill cinder, etc., used was 244,104 tons, while the quantity of imported ore used was 1,117,260 tons. The total amount of coke used during the year was 847,150 short tons, valued at $3,383,223, of which 520,068 tons, valued at $1,652,125, was made in Canada, and 327,082 tons, valued at $1,731,098, imported from the United States. The quantity of limestone flux charged was 498,462 tons.

Steel.—Returns from seven companies making steel showed a total output during the year of ingots and castings of 706,982 short tons, valued at $16,612,590. Of this amount 685,229 tons were ingots, and 21,753 tons castings. Of the ingots made 225,989 tons were Bessemer steel, and 459,240 tons open-hearth. All of the castings, with the exception of 1,151 tons, were open-hearth steel.

Iron and Steel Bounties.—Following is a statement of the bounties paid on iron and steel during the calendar year 1907, as kindly furnished by the Trade and Commerce Department:—

	Quantity on which Bounty was paid.	Bounty.
	Tons.	$ cts.
Pig iron, made from Canadian ore	95,914·97	201,421 47
" " imported ore	537,803·45	591,583 80
Total pig iron	633,718·42	793,005 27
Steel ingots	666,589·87	1,099,873 37
Steel wire rods	68,738·22	412,417 26
Total bounty paid on iron and steel		2,305,295 90

Asbestos.—Returns of shipments of asbestos from the Eastern Townships, province of Quebec, were received from twelve operating companies, who employed about 2,175 men in mines and mills and paid in wages, $840,684. In addition to these, four other companies were making extensive preparations for active mining and milling in 1908.

The total shipments divided into crude and mill stock were, in 1906 and 1907, as follows:—

——	1906.		1907.	
	Tons.	Value.	Tons.	Value.
		$		$
Crude	3,793	626,895	4,338	830,632
Mill stock	55,490	1,343,983	57,680	1,652,352
Total asbestos	59,283	1,970,878	62,018	2,482,984
Asbestic and asbestic sand	20,127	17,230	28,519	22,059
Total products	79,410	1,988,108	90,537	2,505,043

Exports of asbestos, according to customs returns, were:—

——	Tons.	Value.
		$
Twelve months ending December, 1906	59,864	1,689,257
" " " 1907	56,753	1,669,299

The special features of interest regarding the industry during the year have been an increased output, higher prices realized for the product, further consolidation of mining interests, the introduction of electric power by the Shawenegan Power Company, and the continued successful working of the East Broughton district, which is chiefly a fibre producer.

Coal and Coke.—Each of the coal-mining provinces contributed an increased output to the coal production in Canada in 1907. The total sales and shipments of coal, including colliery consumption and coal used in making coke, were 10,510,961 short tons, an increase of more than 7 per cent as compared with 1906. Of the total, Nova Scotia contributed over 60 per cent, Saskatchewan and Alberta over 16 per cent, and British Columbia over 23 per cent. Alberta shows the largest proportional increase, viz., 23 per cent, and British Columbia next, with an increase of over 13 per cent.

The production by provinces was approximately as follows, the figures, of course, being still subject to correction:—

——	Tons of 2,000 lbs.	Value.
		$
Nova Scotia	6,337,632	12,731,850
New Brunswick	34,584	77,814
Saskatchewan	153,914	259,019
Alberta	1,534,001	3,819,587
Yukon	15,000	60,000
British Columbia	2,435,830	7,611,968
Total	10,510,961	24,560,238

The total production of coke in 1907 was approximately 842,004 short tons, valued at $3,485,533. This is made in ovens in Nova Scotia, Alberta and British Columbia. At the end of the year there were in Nova Scotia about 654 ovens in operation and 173 idle, and in Alberta and British Columbia, on the same date, 850 in operation and 582 idle.

Petroleum and Natural Gas.—The production of petroleum is as usual practically all derived from the Ontario peninsula. Direct returns from the producers have not been obtained, but the production has been estimated on the basis of the bounty of 1½ cents per gallon paid by the Dominion government.

The total bounty paid in 1907 was $414,157.89, representing a production of 788,872 barrels, compared with a bounty of $299,120.36 paid in 1906, representing a production of 569,753 barrels. An increased production in 1907 of over 38 per cent is, therefore, shown.

Natural gas was produced and sold in Quebec province in the vicinity of Louisville; in the Niagara peninsula and southern portion of the province of Ontario, and at Medicine Hat, Alberta; the sales from the Ontario fields constituting over 91 per cent of the total.

The total receipts from gas sold in 1907 show an increase of about 31 per cent over the receipts of 1906, and are now larger than at any time since the gas was first used. About 440 wells were producing gas in 1907, of which 114 were bored during the year.

Portland Cement.—Complete statistics have not yet been received, two companies having not yet been heard from. The figures given below for 1907 are, therefore, subject to this correction, and when complete returns are received, will be increased by an amount probably not exceeding 4 or 5 per cent.

The total quantity of cement made in the fifteen plants from which returns were received, was 2,413,513 barrels, as compared with a total of 2,152,562 barrels made in 1906, showing an increase of 260,951 barrels or over 12 per cent. The total sales were 2,368,593 barrels, as compared with 2,119,764 barrels in 1906, an increase of 248,829 barrels or over 11 per cent. The total daily capacity of the fifteen companies making returns was about 12,400 barrels, the other two companies having a daily capacity of 1,900 barrels, making a total capacity of 14,300 barrels per day. These companies are distributed as follows:—One in Nova Scotia, one in Quebec, thirteen in Ontario, one in Alberta and one in British Columbia. At least six other plants were in course of construction with a total proposed daily capacity of from 10,000 to 12,000 barrels.

Of the seventeen producing companies, twelve use marl and clay, four use limestone and clay, and one uses blast furnace slag. One other company, now in liquidation but with completed plant, made cement from marl. Of the six plants being erected, four at least propose to use limestone.

Detailed statistics of production in 1906 and 1907 are as follows:—

——	1906.	1907.
	Barrels.	Barrels.
Portland cement sold	2,119,764	2,368,593
" manufactured	2,152,562	2,413,513
Stock on hand, January 1	269,553	299,015
" " December 31	302,356	343,935
Value of cement sold	$3,164,807	$3,574,828

The average price per barrel at the works in 1907 was $1.43, as compared with $1.49 in 1906, and $1.42 in 1905.

The imports of Portland cement into Canada in 1907 were:—

——	Cwt.	Value.
		$
Six months ending June	732,684	277,133
" " December	1,621,520	560,387
The year 1907	2,354,204	837,520

This is equivalent to 672,630 barrels of 350 pounds each, at an average price per barrel of $1·245. The duty is 12½ cents per hundred pounds. The imports in 1906 were equivalent to 694,503 barrels, valued at $778,706, or an average price per barrel of $1.12.

There is very little cement exported from Canada. The consumption is, therefore, practically represented by the Canadian sales, together with the imports.

Following is an estimate of the consumption of Portland cement for the past seven years:—

Year	Canadian.	Imported.	Total.
	Barrels.	Barrels.	Barrels.
1901	317,066	555,900	872,966
1902	594,594	544,954	1,139,548
1903	627,741	773,678	1,401,419
1904	910,358	784,630	1,694,988
1905	1,346,548	917,558	2,264,106
1906	2,119,764	694,503	2,814,267
1907	2,368,593	672,630	3,041,223

Exports of the Products of the Mine, Year 1907

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Arsenic	Lbs.	613,504	10,850
Asbestos	Tons.	56,753	1,669,299
Barytes	Cwt.	550	2,750
Chromite	Tons.	892	19,800
Coal	"	1,894,074	4,879,564
Feldspar	"	12,068	37,932
Gold		....	8,029,603
Gypsum	Tons.	375,026	424,794
Copper, fine in ore, etc	Lbs.	54,651,452	8,742,133
" black or coarse and in pigs	"	36,998	7,476
Lead, in ore, etc	"	21,978,177	865,941
" pig, etc	"	3,613,706	163,957
Nickel, in ore, etc	"	19,376,335	2,280,374
Silver, in ore, etc	Oz.	14,813,735	9,941,849
Platinum, in ore concentrates, etc	"	242	4,864
Mica	Lbs.	1,117,010	422,172
Mineral pigments	"	382,624	10,043
Mineral water	Galls.	2,877	1,913
Oil—			
Crude	"	1,125	102
Refined	"	3,132	575
Ores—			
Antimony	Tons.	1,327	37,807
Iron	"	25,901	45,907
Manganese	"	1	22
Other ores	"	11,232	428,250
Phosphate		....	....
Plumbago	Cwt.	2,415	3,036
Pyrites	Tons.	25,056	80,139
Salt	Lbs.	2,222,542	7,709
Sand and gravel	Tons.	298,095	119,853
Stone, ornamental	"	153	1,262
" building	"	225	1,825
" for manufacture of grindstones	"	460	5,154
Other products of the mines		....	190,720
Manufactures—			
Bricks	M.	802	6,193
Aluminium, in bars, etc	Lbs.	5,478,203	1,109,353
" manufactured		....	1,499
Cement		....	9,618
Clay, manufactures of		....	369
Coke	Tons.	70,617	320,357
Grindstones, manufactured		....	32,534
Gypsum, ground		....	557
Iron and steel—			
Stoves	No.	698	8,077
Castings, N.E.S		....	33,595
Pig iron	Tons.	439	13,504
Machinery (Linotype machines), 9 months		....	33,926
" N.E.S		....	436,793
Sewing machines	No.	4,193	77,232
Typewriters	"	5,430	163,719
Hardware (tools, etc.), 9 months		....	48,909
" N.E.S.		....	128,417
Scrap iron and steel	Cwt.	229,229	185,430
Steel and manufactures of		....	477,766
Lime		....	55,903
Metals, N.O.P		....	63,700
Plumbago, manufactures of		....	2,847
Stone, ornamental		....	3,576
" building		....	657

APPENDIX I.

COMPARISON OF INDUCTION FURNACES AT PRESENT EMPLOYED FOR THE PRODUCTION OF STEEL.

(By A. Grönwall, Electrical and Metallurgical Engineer, Ludvika, Sweden.)

The principle of the induction furnace is, as is well known, that the iron bath forms the secondary circuit of a transformer, and that it is heated by means of the electric current induced therein.

The iron bath forms only one winding, and the current induced, is therefore, as many times larger than the primary current as the numbers of windings in the primary coil. In the construction of an induction furnace, the phase displacement, and the losses of heat, must be made as small as possible, in order that a good efficiency may be obtained.

For such furnaces, the following approximate formula can be used:—

$$\text{tang. } \Phi = \frac{c.x\ n}{w}\left(\frac{1}{Wp} + \frac{1}{Ws}\right)$$

where: Φ = angle of phase displacement.
c = constant.
n = number of cycles per second (frequency).
w = ohmic resistance of the bath.
Wp = magnetic resistance of the primary leakage field.
Ws = magnetic resistance of the secondary leakage field.

According to this formula the power factor is increased by:

(1) decreasing the frequency.
(2) increasing the ohmic resistance of the bath, by increasing the length of the bath, and decreasing its section.
(3) increasing the resistance of the two leakage fields, by decreasing the area enclosed by the bath.

The induction furnaces which so far have been in practical operation, are those designed by Kjellin, Frick, Rochling, and the Electro-Metal Company.

In the following comparison between these furnaces, an attempt will be made to investigate as to what degree the electrical requirements are fulfilled.

The furnaces designed by Kjellin, and Frick, have the primary coil placed around the leg of the transformer, which is surrounded by the bath.

Kjellin places the primary coil at the same height as the bath, and inside same; while Frick has the primary coil placed either above or below the bath. Both these designers use a ring-shaped crucible. In accordance with the above formula, the furnace has to be designed in such a manner that, the bath has great length; but at the same time incloses only a small area. The circle is, however, that geometrical figure which incloses the largest area with a certain length of periphery, hence these furnaces are designed contrary to the foregoing formula.

In the Kjellin furnace the primary coil is placed comparatively close to the bath whereby the insulation is easily damaged in cases where no special cooling arrangement is provided. On this account, Kjellin places a water-cooled jacket between the primary coil and the crucible. This protection requires a comparatively large space, thus increasing the area enclosed by the bath, and thereby also the phase displacement.

Furnaces of this construction, and of even larger capacity, can be obtained either by increasing the diameter of the crucible, or by increasing the section of the bath. In the former case, the increase of the area inclosed by the bath, and in the latter case the decrease of the ohmic resistance, decreases the power factor.

For small furnaces of this type, a current of 15 to 25 cycles may be used; for larger furnaces (4 to 6 tons charge) the frequency has to be decreased to about 5 cycles per second.

This low frequency necessitates the employment of expensive electrical machinery.

The induction furnace at Volklingen designed by Rochling has an 8-shaped crucible. The two legs of the transformer—each provided with a coil—are surrounded by the baths, and communicate by means of a broad groove placed between the legs of the transformer. The furnace has also two carbon electrodes, placed opposite each other at each end of the groove. The iron bath is consequently heated by the current supplied by these electrodes, as well as by the induced current. The electrodes consist of iron plates on which are stamped a mixture of magnesite, and carbon. The object of the carbon in this mixture is to increase the conductivity; but the amount of carbon used must be small, in order that the electrode may not be dissolved by the iron bath.

The arrangement with an 8-shaped crucible does not cause any advantages from an electrical point of view, as compared with an ordinary induction furnace with ring-shaped crucible.

One may assume that the 8-shaped crucible is obtained by dividing the bath and the primary coil of a ring-shaped induction furnace in two equal parts by a horizontal plane, and moving one part to the other leg of the transformer. By such an arrangement no electrical changes occur, and the power factor is not increased. The radiation losses are, however, about twice as large as before, and the efficiency of the furnace is decreased. The arrangement with carbon electrodes increases the power factor; but decreases the efficiency on account of the energy lost by the electrical resistance of these electrodes.

Several attempts have been made to construct an electric furnace in the same manner as an open-hearth furnace, with the electrodes placed in the two opposite walls, similar to the Rochling furnace; but without transformers. A furnace of this kind would certainly be ideal; but the attempts made have been failures, owing to the fact that, the current required must be of a very low voltage; on account of the low resistance of the molten iron, as well as the relatively short length and large section of the bath.

In my opinion, a combination of an electrode furnace, and an induction furnace of low efficiency, is not satisfactory. The total efficiency of such a furnace must be lower than that of other electric furnaces of like capacity.

The Electro-metal Company, of Sweden, has designed an induction furnace which has a bath consisting of two parts. One part of the bath forms an open ring close around the leg of the transformer; while the other part consists of two parallel grooves connected with each other, and with the circular groove in such a manner, that a continuous groove is obtained.

This form of crucible permits a relatively great length of bath; but at the same time the area enclosed is comparatively small. On account of the great length of the bath, the cross-section can be made relatively small, while the ohmic resistance is increased. The furnace is consequently constructed in accordance with the conditions required by the theoretical formula.

The primary coil is placed around the outer leg of the transformer, which is a great advantage. In this case, the coil designed for a current of high voltage, needs no special protection from the heat radiating from the crucible; and no danger of the workmen touching the live wire needs to be feared. This method of placing the primary coil around the outer leg of the transformer is made possible by a compensation arrangement, consisting of two copper coils, designed for a current of low voltage, and thus easily insulated, even for high temperatures. In order to decrease the leakage from the transformer core, the sheets of iron or lamellæ are put together in such a manner, that wherever the leaking lines of force try to escape from the iron core, they are forced to pass through a smaller, or greater number of these lamellæ. According to observations made, the leaking lines of force emanate chiefly from the edges of the lamellæ. Owing to the 'screening action' which the iron sheets exercise in a transformer constructed on the above principle, this leakage is considerably decreased.

The induction furnace possesses many advantages over the ordinary crucible furnace. The electrical energy required is so small, that even with relatively high-priced power the electric furnace is more economical than a crucible furnace. In the induction furnace, as well as in the crucible furnace, the iron is protected from impurities; for neither the carbon nor the gases come in contact with the metal. In the electric furnace, however, the slag, and gases, are more easily and completely separated from the molten metal, on account of the vibrations caused by the alternanations of the current. Finally, a more homogeneous product, at the required tapping temperature, is obtained from an electric furnace of suitable size, than from a great number of small crucibles. With crucibles, it is difficult to obtain the same temperature in all the crucibles, and when pouring the contents the metal is more exposed to the air.

APPENDIX II.

ABSTRACT SHOWING RESULTS OF EXPERIMENTS IN INTENSIFIED NITRIFICATION BY MEANS OF PEAT BEDS.

(MM. Müntz and Lainé.)

The experiments on the process of nitrification were carried on with the view of establishing plants, or nitre beds for the production of nitrate on a large scale, by methods more expeditious, and giving larger yields than by the old processes.

These studies were not undertaken with the object of applying the principle to agriculture; for it is not very important that available (or soluble) nitrates be given direct to the land, since the soil to which is added nitrogenous matters itself undertakes their transformation into nitrates. Our main object has been the production of nitrogen—(nitrates) necessary for the manufacture of war ammunition—(explosives).

It was thought that great progress would be made by the establishment of artificial fields (or beds) for nitrification; based on the introduction of nitrogen in the form of ammoniacal salts, such as by-products from the manufacture of gas, and coke, and the distillation of scavenging matter.

In all the experiments carried on with soils, moulds (artificial soils obtained by a mixture of calcareo-siliceous earth, horse manure, and leaves), and various kinds of peats, without the addition of ammoniacal salts, only a very small production of nitrate was obtained; the proportion of which would be negligible as compared with the quantity of nitrate which could be produced in the same period by the addition of ammoniacal salts.

The following tables give results obtained from these preliminary experiments, which were carried on from October 26, 1905, to March 21, 1906. The various earths were kept moist, and stirred regularly.

—	Nitrogen in Nitric State. Oz. per 10 lbs.		Quantity of nitrogen oxidized in 85 days. Oz. per 10 lbs.
	December 26, 1905.	March 21, 1906.	
Garden earth	·00352	·01232	·00880
Siliceous-calcareous earth	·00304	·00608	·00304
Mould	·01136	·03904	·02768
Clayey earth	·00304	·00512	·00208
Calcareous earth	·00144	·00416	·00272

With peat to which calcium carbonate had been added—affording, therefore, the most favourable conditions—similar results were obtained.

—	Period of Nitrification.	Nitrogen oxidized. Oz. per 10 lbs.
Compact peat from Yonne	257 days	·00256
Mossy peat from Yonne	257 "	·00608
Mossy peat from Holland	257 "	·00256
Mossy peat from Somme	175 "	·00816
Compact peat from Somme	175 "	·00416

Therefore, humic nitrogen from black compact peat, is practically inert towards micro-organisms. In surface mossy peat, it is rather more available (assimilable) although for the purpose in view, the quantity is negligible.

The objection may be made that, in such experiments nitrifying agencies are not very active: i.e., a lack of nitrifying ferments.

To answer this objection, the following experiments were made on mould, mossy peat from Somme, and compact peat from Somme. The two last named were finely divided, moistened, and carbonate of lime added. One series was set to nitrify without the addition of foreign ferment. Another was set with the addition of 1 per cent of mould in state of forced or intensified nitrification.

Again, a third and fourth series were respectively sterilized by heating to 230° F.; then to one was added ordinary mould, and to the other 1 per cent of mould under intensified nitrification.

After 178 days the materials were tested for oxidized nitrogen.

—	Nitrogen, Oxidized per 10 lbs.			
		Not Sterilized.	Sterilized.	
	Without addition.	1 p.c. of mould intensively.	Mixed with 1 p.c. ordinary mould.	1 p.c. of mould by intensified nitrification.
	oz.	oz.	oz.	oz.
Mould	·06576	·06944	·08928	·10016
Mossy peat	·01408	·02000	·02538	·02416
Compact peat	·02432	·02624	04688	·04160

Concentration of Ammoniacal Solutions in the Liquids Held by Soils.

It is very interesting to note the activity of the nitrifying ferments, when accompanied by ammoniacal salts, which confirms the previous observations of scientists who have made studies of the process of nitrification in saline solutions of varied strengths. MM. Boullanger and Massol have shown that, in solutions holding more than 1·24 oz. of ammonium sulphate per gallon, nitrification does not reach completion, and that it is stopped when the proportion is greater than 6·5 to 8 oz. per gallon.

Reference has been made to the reasons which led to the experiments on the introduction of ammoniacal salts as raw material in the production of nitrate; but it is a well-known fact that these salts, when employed in large doses, actually impede nitrification. It was, therefore, very interesting to determine the optimum dose of ammoniacal salts which could be used to obtain the most intense formation of nitre.

Experiments were made on samples of the following earths:—

	Per Cent of Water.
Garden earth	21·85
Silico-calcareous earth	15·42
Mould (artificial)	53·90
Clayey earth	16·20
Calcareous earth	12·59

The results indicate that, the concentration of ammonium sulphate has no marked effect on the progress of nitrification if it does not exceed a limit of 1·44 oz. per gallon of the water contained by the soil.

This is confirmed by previous experiments, in which the process of nitrification still went on when the water of impregnation contained as much as 8 oz. per gallon.

In establishing nitre beds based on the principle of the transformation of amonium sulphate, the rule to be followed for the addition of ammoniacal salt is not the proportion of earth brought into action; but the proportion of water held by the earth. The solid earth enters into the process only so far as its capacity for water is concerned; while those which can retain a larger amount without being submerged, are capable of receiving larger proportions of ammoniacal salts. In fact, the action of nitrification has to be considered independently of the earthy particles; which only act as supports for the development of nitrifying organisms.

Thus, in an earth containing only 12 per cent of water, a proportion of 1 oz. per 10 lbs. of earth should not be exceeded; whereas in an earth capable of retaining 50 per cent of water, a proportion of 5 oz. per 10 lbs. may be used without impeding nitrification.

In practice, the optimum proportion should be much below these figures to obtain the maximum intensity of nitrification. For earth containing 12 per cent water, the amount should be about 2 oz. of ammonium sulphate per 10 lbs. For earth capable of retaining 50 per cent of water it may reach 6 oz. per 10 lbs. Therefore, the humic earths capable of retaining 60, and sometimes 80 per cent of water, are particularly well adapted for the enrichment in ammonium sulphate—without the risk of a decrease of the oxidizing phenomena.

Substitution of Peat for Soils and Moulds.

After having experimented on the active part performed by organic materials in intensified, or forced nitrification, we thought that peat, which is in large proportion composed of these moulds, offered a good base for nitrification.

Instead of operating on various soils, and on garden mould, as in previous researches, peat, on which a few experiments had been made as to its adaptability as a nitrifying medium, was operated on.

The following materials were taken:—

(1) A compact peat from Yonne, containing 57·93 per cent water.

(2) A mossy peat from Yonne, containing 68·26 per cent water.

(3) A moss litter from Holland, containing 59·60 per cent water.

To these peats had been added 100 ounces of Meudon chalk, 5 ounces phosphate of lime, 1 ounce potassium sulphate, and 50 ounces of garden soil, per 10 pounds of peat. Further, sulphate of ammonium was added, which was replaced as nitrification proceeded.

On April 9, 1906, these were started, and analyses resulted as follows:—

—	Oxidized Nitrogen per 10 lbs.		
	Compact peat.	Mossy peat.	Moss litter.
		Oz. per 10 lbs.	
April 28	·33952	·40672	·48064
May 23	·59984	·61424	·67296
August 2	1·69936	1·35072	1·59728

This shows a very intense nitrification, manifestly superior to that undergone by even the mould, and corresponding to an increase of:—

—	Oz. per 10 lbs.		
	Compact peat.	Mossy peat.	Moss litter.
	oz.	oz.	oz.
Oxidized nitrogen per day	·01584	·01040	·01296
Corresponding to nitrate of lime per day	·09280	·06096	·07600

By continuing to add ammoniacal salts, the enrichment reached the following figures:—

—	Oz. per 10 lbs.		
	Compact.	Mossy.	Moss litter.
Oxidized nitrogen per 10 lbs	1·83360	1·89008	1·74624
„ to nitrate of lime	10·73600	11·05760	10·21760

and the limit of enrichment was not reached even then.

It will be seen, therefore, that peat constitutes a more active medium for nitrifying beds, than soils, or even moulds. As its value as a merchantable product is practically nil, it could be substituted with great advantage for material usually employed in the making up of nitrifying beds.

Therefore, peat offers the best medium for forced (or intensified) nitrification, and it should constitute the basis of nitrifying beds of high yield.

A cubic yard of peat gives by dessication, 590 pounds of dry matter, containing two per cent nitrogen. Considering a thickness of forty inches in peat bogs, an area of two and a half acres would contain 165,000 pounds of nitrogen in an inert state.

It is apparent from the results of these experiments that, nitre beds of peat yield results as good, or even better than mould; and as there exist practically inexhaustible quantities of this material, its use in the establishment of nitre beds is strongly recommended. Both the surface mossy peat and the underlying compact peat are suitable for the purpose; provided that the proportion of earth in this last mentioned material be not too high.

Installation.

Seeing that peat, as taken from the bogs, generally contains considerable water, and is rather friable, it can easily be finely divided, and brought to the texture of gardener's mould.

Peat, as a rule, does not contain carbonate of lime, hence it is necessary to add some of this material—to the extent of 10 per cent. The carbonate of lime should be as rich, and pure as possible: i.e., it should not contain much clay, or silicates. The friable chalk, which mainly constitutes the rocks of Champagne, France, and, generally speaking, rocks of the Cretaceous formation, are suitable.

This material should be as finely divided as possible. It would also be advisable to add about one per cent of phosphate of lime, the effect of which is very marked in the development of micro-organisms.

The mixture of peat, and calcareous matter, after being made homogeneous, should be brought to a state of moisture—best determined by the hand. It should have the feeling of well-drained gardener's mould; but be sufficiently moist that a handful of it when squeezed in the hand, shall remain coherent, and not fall to pieces on releasing the pressure. This means a proportion of 55 to 60 per cent of moisture in weight. After the starting of the nitre bed, this degree of moisture must be maintained by sprinkling water over it, and mixing, to distribute it evenly throughout the mass. This will, moreover, ensure aeration, and the multiplication of the nitrifying organisms. Peat in its natural state contains these fermenting agents, and to ensure their preponderance over the other micro-organisms, it will be sufficient to supply them with ammoniacal salts and to ensure favourable conditions as to aeration, temperature and moisture. As these organisms are not very active at the beginning, a great deal of time may be gained by adding material from another nitre bed in full activity. For this purpose, it would be advisable to add to the peat about one per cent of material in active nitrification.

The mixture thus prepared, should be placed where it can be heated to the necessary temperature, preferably on a cemented or paved floor, which, by its non-porosity and smoothness, would decrease the liability of counteracting agents to take a hold.

A heap should be made, analogous to those employed in mushroom culture. Its thickness should not be over 40 inches. As to temperature, it should be kept between 77° and 83° Fahr. It is better to keep this low temperature; although the degree of heat most favourable to the development of pure nitrifying ferments is about 97° F.; but this temperature is also favourable to the antagonistic ferments. It has been noticed, in the course of our experiments, that the more abundant these antagonistic agencies are, the further from 97° F. should the temperature be kept.

The most favourable conditions are, then, (1) the abundance of organic matter, favouring the development of nitrifying elements, and (2) a sufficiently low temperature to check the development of antagonistic elements.

Maintenance and Culture.

The nitre bed is now ready to receive the ammoniacal nitrogen. We use the sulphate, as it is the cheapest and the most profitable. The experiments have shown that nitrification could take place with solutions containing as much as 1·0 to 1·25 oz. of ammonium sulphate per gallon; but it is better not to use stronger solutions than ·125 to ·160 oz. In the particular case of a peat nitre bed containing 60 per cent moisture, the best results would probably be obtained by introducing ·48 oz. of ammonium sulphate per 10 pounds, which would give solutions of ·801 oz. per gallon per cubic yard of peat in nitrification—which weighs 850 to 925 pounds. Each time it would be necessary to use about 2·9 pounds of ammonium sulphate.

In the presence of this element, the nitrifying ferments, either pre-existing in the peat or added as 'seed' will find a particularly favourable field for their development. They will multiply, and by natural selection may give rise to more active organisms; but at all events they will assume a preponderating role among the organisms present in this medium.

By a series of analyses, the transformation of the ammoniacal nitrogen into oxidized nitrogen can be followed daily. As the latter grows, the ammoniacal nitrogen begins to disappear, and is entirely lost in a short time. If the supply of ammoniacal nitrogen were not renewed there would be a change in the role, or action of the microorganisms; for lack of food the nitrifying agents would be overcome by the organisms which transform the oxidized nitrogen, or ammoniacal nitrogen into insoluble or gaseous products, and this would be lost to the nitrification process.

It is, therefore, very important to have ammoniacal nitrogen always present in the nitre bed. By frequent assays, a proportion of ·10 oz. ammoniacal nitrogen or ·5 oz. of ammonium sulphate per 10 lbs. of moist peat is ascertained to be present.

The best way to introduce the ammoniacal salts is to dissolve them in the water with which the nitre bed is sprinkled, to maintain the right degree of moisture.

The carbonate of lime first added has always a tendency to become exhausted, and care should be taken to have it always present in excess, which is indispensable to the process of nitrification, as its total disappearance would stop the conversion. It is used up with comparative rapidity. For the nitrification of one molecule of ammonium sulphate, it requires two molecules of calcium carbonate to saturate the sulphuric acid of the added sulphate, and the nitric acid of the nitrate formed. For every 4·66 oz. of sulphate of ammonium which disappears 7·10 oz. of calcium carbonate will be consumed.

Therefore, for every part of ammonium sulphate, about two parts of chalk containing 75 to 80 per cent of calcium carbonate, will require to be added. This addition need not be made as frequently as that of the ammonium sulphate, it is sufficient to occasionally ascertain that it is present in excess. To a small sample of the peat add a few drops of hydrochloric acid. If it sets up an active effervescence, then the calcium carbonate is in sufficient quantity, but the effervescence must not be in isolated spots in the peat, which might be caused by particles of carbonate of lime harder and more resisting than those suitable to sustain an intensified nitrification, as calcium carbonate in a very fine state of subdivision well distributed throughout the mass.

The sprinkling water in which the sulphate of ammonium is dissolved, and the calcium carbonate added, should be well and evenly distributed throughout the nitre-bed. This is effected by a stirring up of the peat, which operation, moreover, is necessary to ensure good aeration. Frequently, every day if possible, the beds should be stirred, subdivided as much as possible, and brought into contact with air.

With a spade, take from the side of the bed a slice some eighteen inches thick. This is to be disintegrated as much as possible, and placed eighteen inches farther; the upper part of the first bed being put on the floor, thus forming the bottom of the second bed. Proceed until the whole bed has been thoroughly stirred.

Such are the first operations in the establishment of nitre-beds; but tab should be kept on the progress of the process by analyses for nitrogen. An assay once a month is amply sufficient. The process of nitrification, which is very slow at the start, increases in intensity, and will have reached its normal rate at the end of one month.

From our researches the daily production of nitrified nitrogen is about ·016 oz. per 10 lbs. of moist peat; which corresponds to about 1·35 oz. of oxidized nitrogen, or 10 oz. of nitrate of potash per cubic metre of the nitre-bed.

From the second month this production is maintained until the solutions of nitrate of calcium become sufficiently concentrated to lessen the nitrification. This concentration corresponds to about 32 oz. of nitrate of potash per gallon; or 1·9 oz. per lb. of moist peat, or 110 lbs. per cubic yard of the peat bed. From the experiments conducted this result would be reached at the end of 170, to 180 days, or about six months. The nitre-bed having reached at this time the limit of enrichment, it becomes ripe for exploitation. This 'harvesting' should be done without delay: without waiting until nitrification has suspended altogether. For, when the process diminishes in intensity, the phenomenon which take place at the beginning, reappears, and results in the loss of nitrogen.

The leaching of the nitrified peat, offers no difficulty. It can be effected by the methods used in the case of the old artificial nitre-beds, which had reached a high degree of perfection. The methodical leaching yields a concentrated solution, showing about 15 degrees on Beaume's hydrometer, and containing 15 per cent of nitrate of calcium. We shall state later on how this can be treated for the production of nitric acid, or of nitrates of the alkalies.

It is not necessary to go to much labour to ensure a perfect leaching of the materials. These are used in the establishment of a new nitre-bed. It will be sufficient to roughly drain the peat to the required degree of moisture, and to add to it, if necessary, a new quantity of calcareous matter, and to put it into heaps as stated before.

By operating in this way, the same materials can be used several times over, which constitutes a considerable saving.

If we compare the yield which we obtain by this method, with the results of the old methods of nitrification, we are at once struck by the much greater yield. Formerly, in a good nitre-bed, the yield, after two years of nitrification, was five kilos. of saltpetre. With a good peat bed this quantity is obtained in twenty-four hours, which means a yield sixty times greater in the same period, for a nitre-bed of equal volume. There are no apparent reasons why this process could not be applied to the production of nitre in enormous quantities, by the establishment of nitre-beds which would yield 2,400,000 lbs. of saltpetre on an area of one acre, having a thickness of one yard.

Notwithstanding these comparatively large quantities, it was endeavoured to increase them by substituting for nitre-beds of earthy, or peaty matter, beds in which the ammoniacal solution flows continually over an oxidizing medium; made up of heaps of peat containing nitrifying organisms. These experiments have been very successful.

Nitre-beds Operating Continuously.

Formerly, nitrification was not conceived to be possible without earthy materials; since to their porosity was attributed the preponderating role of oxidation of the ammonia, and of the organic matters, which resulted in the formation of nitre. But MM. Schloesing and Müntz showed by their researches, that porosity was only a secondary condition, and that the process of nitrification was induced by a fermentation which went on in solutions which were sufficiently aerated. This phenomenon is increased in intensity when the liquid flows in a thin sheet in contact with air. This action is further increased when the materials over which the liquid flows offer an irregular surface, which multiplies its contact with the oxygen of the air.

This principle has been applied in the purification of sewerage water, and even of water supply, notably in England. Oxidizing fields have been established by making beds of clinkers and cinders (from combustion of bituminous coal), broken into fragments the size of walnuts, over which the waters to be purified are made to flow. The fragments of clinkers must become coated with colonies of active organisms, before the phenomenon of oxidation acquires its normal intensity: which becomes very active in a certain time.

It was endeavoured in the experiments to give this principle a partial application, for the production of nitrates in large quantities, in solutions much more concentrated, which could afterwards be treated for the extraction of saltpetre.

Experiments were made with broken cinders, and with bone black. Two glass bells of about 4·4 quarts capacity, with an opening at the bottom, were filled, one with broken cinders of the size of a filbert nut, and well washed, and the second with bone charcoal (refinery bone black), in coarse grains. These were moistened with nitrifiable solutions containing 0·4 oz. of ammonium sulphate per gallon, as well as the elements mentioned by M. Omeliansky, namely, phosphate of potassium, sea-salt, carbonate of magnesia; and to these was liberally added mud from soils. Through the two bells, maintained at a temperature of 86° to 95° F., a slow current of air was passed, induced by a water suction pump. Twice a day they were sprinkled with about 2·5 cubic inches of the nitrifying solution.

The action of nitrification was soon induced after having passed through the phases usually observed in liquid mediums. Nitrates first appeared, and after about ten days the liquids collected from the lower part of the vessels contained only very small proportions of ammonia. On the eleventh day after starting, the liquids contained per litre:—

——	Bone black.	Cinders.
Nitrogen in Nitrous state	·061 oz. per gal.	·059 oz. per gal.
" Nitric state	·0063 " "	trace.
" Ammoniacal state	·003 " "	·006 oz. per gal.

From the above, the bone black, and the cinders, seem to be equally suited as 'supports.' From this day, nitrates gradually disappeared from the two vessels, and were replaced by nitrates; and to the nitrifying solutions ammonium sulphate was added to bring the solution to a concentration of 1·2 oz. per gallon. The volume of liquid passed through in twenty-four hours was also increased, so as to attain a maximum production of nitrates in a given time. It was endeavoured to ascertain this maximum by frequent analyses of the nitric solutions.

The experiment was started on March 20, and hereunder some of the results are tabulated:—

Dates.	Strength of nitrifying solution per gal.	Val. passed in 24 hours.		Nitrogen oxidized per gal.		Nitrogen oxidized in 24 hours.	
		Bone charcoal.	Cinders.	Bone charcoal.	Cinders.	Bone black.	Cinders.
	oz.	oz.	cub. in.	oz.	oz.	grains.	grains.
May 17	1·20	9·76	4·88	·118	·186	1·820	1·435
June 27	1·20	14·64	4·88	·204	·183	4·738	1·404
July 3	1·20	21·96	21·96	·194	·134	6·744	4·630
" 11	1·20	29·28	29·28	·187	·105	8·657	4·848
" 17	1·60	21·96	21·96	·154	·069	5·355	2·393

From these figures several conclusions can be drawn. They show that with solutions stronger than 1·2 oz. ammonia sulphate per gallon, corresponding to ·224 ounce of ammoniacal nitrogen per gallon, the process of nitrification is notably decreased. Therefore, in practice, the concentration of nitrifying solutions cannot be increased.

With a proportion of 1·2 oz. per gallon, and with the speed of flow mentioned, nitrification of ammonium sulphate was not completed, for out of ·240 oz. of ammoniacal nitrogen used, only ·190 oz. were oxidized, even under the most favourable conditions. With the increase of concentration the quantity of nitrified nitrogen, instead of increasing, fell from ·190 oz. to ·145 oz.

These facts will have to be taken into consideration when operating with solutions flowing in sheets over porous material, or material with irregular surface, and to obtain a maximum intensity of nitrification the solution should not be stronger than ·190 oz. to ·240 oz. ammoniacal nitrogen per gallon.

By comparing the action of the cinders with that of the bone charcoal, we see that this last offers a more favourable support for nitrification. 4·4 quarts of cinders produced only 4·60 grains of nitric nitrogen in twenty-four hours, whereas the same volume of bone charcoal gave 8·64 grains.

These figures are sufficiently high to apply the process to the production of large quantities of nitrates, 5 litres of bone charcoal having produced in twenty-four hours 8·64 grains of nitric nitrogen, corresponding to ·127 oz. of nitrate of potash. One cubic yard would, therefore, produce 19·38 oz. of saltpetre per day.

This yield is about double that of the best nitre beds of peat or mould, on which experiments were carried on, and to which was added ammonium sulphate for intensified nitrification. Therefore, the continuous flow of ammoniacal liquids over the oxidizing field is superior to the nitre beds, even under intensified condition.

On the other hand, this process by bone charcoal presents drawbacks. This material is costly and the establishment of such a nitre plant would represent a large outlay. Also, the state of weakness of the solution would entail a considerable evaporation of water. The nitrified liquid does not hold much more than 1·45 oz. of saltpetre per gallon, which would considerably impair the value of the process of nitrification, in spite of its rapidity.

It is, however, expedient to endeavour to enrich these liquids in the proportion of nitrates, so as to diminish as much as possible the cost of concentration. We stated that the initial proportion of ammoniacal salts cannot be increased without decreasing the nitrifying activity; it is, however, well established that liquids rich in nitre will go on nitrifying after the addition of ammoniacal salts. MM. Boullanger and Massol have shown that, in a solution corresponding to 4 oz. of nitrate of potash per gallon, nitrification goes on without decreasing, so long as small quantities of ammoniacal salts are added; which are replaced as soon as they have disappeared. On the other hand, the present researches have shown that in nitre beds the maximum concentration attainable was much higher, and reached about 32 oz. of calcium nitrate per gallon.

It was, therefore, thought that, instead of evaporating the solution containing only one per cent of nitre, a quantity of ammoniacal salts—equal to the original tenor—might be introduced by pouring it over an oxidizing field; replacing each time the ammoniacal salt, up to the limit at which the proportion of nitre interferes with the process of nitrification.

This was not done by bone black, but with a peat medium, by which results even more satisfactory, and more practical were obtained.

The results obtained, show that this enrichment is possible, and that the process of nitrification by pouring, or flowing ammoniacal solutions over fields (solid supports), allows the production of large quantities of nitre in solutions sufficiently rich to be economically evaporated.

Peat from Holland was secured—very mossy in character: such as is used instead of straw for litter in stables. This was divided into fragments the size of a walnut, and soaked in a nitrified solution containing ·4 oz. of ammonium sulphate per gallon, to which had been added finely ground carbonate of lime, and a little garden earth.

This was introduced into a glass jar with opening at the bottom, and allowed to drain naturally; but so that the peat would retain the calcium carbonate. The jar was maintained at a temperature of 86° to 95° F., and a current of air was kept circulating through it. Each day it was sprinkled with 11 cubic inches of nitrifiable solution, containing ·4 oz. of ammonium sulphate per gallon, and the liquids collected were tried for the unnitrified ammonia.

The experiment was started on January 25. On February 3, nitrification was complete and the concentration of the sprinkling solution was increased to ·8 oz. and on February 15 further increased to 1·0 oz. At this time the organisms were sufficiently active to nitrify 22·9 cubic inches of the 1·0 oz. solution, without leaving any ammonia residue.

This first experiment shows that mossy peat can be used to replace bone black, and it was endeavoured to determine the power of nitrification of which peat is capable under the most favourable conditions.

INFLUENCE OF TEMPERATURE.

The experiments were made on two samples of peat very dissimilar in nature. One was the litter moss from Holland, the other was compact peat, advanced to a state of decomposition, from a bog at Andryes (Yonne). These samples—the first of which was thoroughly air-dried—were impregnated with a nitrified solution of ·4 oz. of ammonium sulphate per gallon, to which had been added 4·4 quarts of peat, 7·04 oz. of Meudon chalk and earth mould, to inoculate (introduce) with active organisms.

CONCLUSIONS.

From the series of experiments carried on it appears that: (1) During the period of development of the organisms, temperature has a marked effect, and the optimum is about 95° F. (2) During the period of active nitrification, temperature has not so marked an effect. Between 77° and 96° F., its influence does not vary much. In practice we would recommend keeping it between 80° and 82°.

STRENGTH OF AMMONIACAL SOLUTIONS.

In compact peat, up to a strength of 4·57 oz. of sulphate of ammonium per gallon, nitrification was not notably influenced by the proportion of the salt. With a solution of 6·40 oz., the activity slightly decreased; but it was still very active. With mossy peat a slight decrease was noticed above 1·20 oz. per gallon, but kept on actively with the 6·40 oz. solution. The limit of concentration which annuls nitrification was not reached. There is no object, however, in using stronger solutions than 1·20 oz. per gallon, as above this limit the quantity of nitrate formed has a slight tendency to decrease.

By using stronger solutions there would be an excess of un-nitrified ammonia, and in order to save it, the solutions would have to be sprinkled again over the nitre-bed; or else the ammonia would have to be recovered by distillation.

A certain portion of this ammonia is liberated by the calcium carbonate, from the ammonium sulphate by a double decomposition; resulting in the formation of volatile ammonium carbonate, which will have a stronger tendency to volatilize in the more concentrated solutions.

INTENSITY OF NITRIFICATION IN PEAT MEDIUM.

The figures and experiments which precede, show the great adaptability of peat to serve as a support or medium for nitrification. The yields obtained are very high. The best results per unit of time and per unit of volume of the nitre-bed were obtained with solutions containing 1·2 oz. of ammonium sulphate per gallon.

On April 19, the following results were obtained by passing 89 cubic inches of this solution over 69 cubic inches of peat at a temperature of 96°.

——	Oxidized Nitrogen per gallon of solution.	Oxidized Nitrogen in 24 hours, per cubic decimetre of peat.	Nitrate of calcium per cubic yard of peat.
	Oz.	Oz. per cu. ft.	Lbs. per cu. yd.
Mossy peat ..	·100	·897	8·82
Compact peat....	·122	1·1	10·82

As compared with results obtained over bone black, the process of nitrification is ten times more intense over the peat.

To what can be attributed the favourable influence of peat on the activity of microbe colonies present in it? It is not to porosity, for the mossy peat, which is extremely porous, did not give results superior to those obtained from the compact peat, which was almost earthy. It must rather be ascribed to the presence in peat of humic organic matter, which constitutes a medium very favourable to the development of nitrifying ferments. It is also due to the particular rugosity of the surface, which affords a good hold to colonies of micro-organisms, and protects them from the current of the solutions, which might otherwise carry them away.

If we compare the quantities of nitre which can be obtained by this process with the yield of the old fashioned nitre-beds, an enormous difference is noticed; for, with an installation of the same importance, the yield of saltpetre would be about one thousandfold greater in the same time.

We can now foresee the possibility of transforming large quantities of ammoniacal salts into nitrates in a short time. But by using the method of constant flow of ammonium sulphate solution over peat, which serves as support for the nitrifying organisms, a stronger liquid than 1·2 oz. per gallon cannot be used; which, after passing over the peat, would give a liquid containing a little less than 1 per cent of nitrate of lime, and would entail evaporation of a great volume of water.

CONCENTRATION OF THE NITRATE OF LIME SOLUTIONS.

An endeavour was made to enrich the solutions by further nitrification. As mentioned above, this is possible even in solutions containing 32·05 oz. of nitrate of lime per gallon. The following course was adopted: To the solutions already nitrified by passing over the bed, a certain quantity of ammoniacal salt was added. and this was passed again over the same, or another nitrifying bed; the operation was repeated until a sufficient degree of concentration was obtained to allow of economic extraction. In other words, the liquids already nitrified were recharged with a further supply of ammoniacal salt and further submitted to the nitrifying process to enrich them gradually.

A series of jars, with opening at the bottom, were prepared. They were filled with pieces of peat, mixed with earthy mould charged with nitrifying ferments, and soaked in a mud of Meudon chalk, and a ·4 oz. solution of ammonium sulphate per gallon. These jars were then regularly sprinkled with a ·4 oz. solution until the process was well established. Then the concentration of the solutions was carried to ·8 oz., and later on to 1·2 oz. After this point was reached the experiment was carried on as follows:—

The first jar (A) was sprinkled with a solution containing 1·2 oz. of sulphate ammonium, and 2·56 oz. of Meudon chalk. The sprinkling was 30·5 cubic inches per day, poured in four parts. Each morning, to the 30·5 cubic inches, which had drained from the first jar (A), were added ·132 oz. of ammonium sulphate and ·264 oz. of chalk, and this was poured over the contents of jar (B). This was repeated in the case of the subsequent jars up to the eighth—the last of the series.

The enrichment was regular, and the results show that it could have been pushed farther.

OXIDIZED NITROGEN PER LITRE.

—	A.	B.	C.	D.	E.	F.	G.	H.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
October 2.......	·200	·427	·756	·993	1·061	1·193	1·307	1·585
" 11.......	·247	·406	·684	·890	1·096	1·260	1·412	1·595

This last content of 1·595 corresponds to 7·576 oz. of calcium nitrate per gallon. This is, therefore, still far from the 32 oz., from which point nitrification becomes impossible, and the number of jars could have been increased.

This experiment shows that solutions of nitrate could be obtained sufficiently concentrated to allow of an economic extraction.

ACCUMULATION OF PLASTER IN NITRE BEDS.

Nitre beds working continuously, receive large quantities of ammonium sulphate and of carbonate of lime. This causes the formation and accumulation of plaster. For each gallon of solution of 1·20 oz. of ammonium sulphate, 1·25 oz. of calcium sulphate will be formed, of which only one-quarter will be soluble. The balance is insoluble, and would be deposited on the peat forming the support. This would, in a short time, result in a notable decrease in the efficiency of the bed.

To obviate this, the simplest method is to eliminate the plaster from the solution before sprinkling. To achieve this, it will be sufficient to allow the nitrified solution to settle after the addition of the ammonium sulphate, and to use the supernatant liquids—which are solutions of ammonium nitrate—to be submitted to nitrification. Therefore, the first bed is the only one which would receive plaster. The subsequent beds will be free from it and can work indefinitely without fear of obstruction.

TRANSFORMATION OF NITRATE OF CALCIUM INTO NITRIC ACID AND ALKALINE NITRATES.

The artificial nitre beds yield us nitrate of calcium. For the manufacture of explosives it becomes necessary to transform it into nitric acid, which can be done by treatment with sulphuric acid, as in the case of sodium nitrate.

But this method might offer difficulties in practice, and would necessitate the modification of manufacturing plants; hence it might be more expedient to transform the calcium nitrate into an alkaline nitrate.

Treatment with potassium sulphate seems to be the best suited. Lime is eliminated in the state of insoluble sulphate, and the liquid freed from this calcium sulphate, and concentrated, yields directly pure crystals of potassium nitrate.

ESTABLISHMENT OF NITRE BEDS WITH CONTINUOUS PRODUCTION.

The foregoing researches have shown the possibility of working on a large scale, by pouring the ammoniacal liquids over peat beds properly prepared, and we are now in a position to formulate certain rules concerning the establishment of such plants.

First, comes the choice of peat best suited for the purpose. We have noticed that it does not make much difference whether mossy peat, or compact peat is used. In our experiments, we have mainly used surface peat, somewhat mossy, and this material appears to be the most practical, as it can be more easily obtained.

Earthy peat, easily powdered, must, of course, be avoided, as it would form mud or slime on being sprinkled with the solutions.

The proper peat should be broken into fragments the size of walnuts, or of eggs. This peat should be sufficiently drained; but it is not necessary to wait for a complete dessication. The pieces will be moistened with a weak nitrifiable solution containing ·32 oz. of ammonium sulphate per gallon; to which has been added finely pulverized chalk, and a little phosphate of lime. The whole should be well stirred to cause a complete absorption of the carbonate of calcium, of which ninety-two pounds may be added per cubic yard.

At the same time, material from a nitre bed in activity must be added. If not available, add good gardener's earth. Seventeen pounds of this should be added to each cubic yard of peat, and disposed in parallelopiped heaps six and a half feet thick; the other dimensions varying with the importance of the nitrifying bed. The sides could be held by strong wire netting. Aeration flues to be maintained in the heaps. Care must be taken to dispose the pieces of peat as loosely as possible, to ensure a good circulation of air.

The lower part of the heap should rest on a layer of broken cinders, or other inert material, to ensure easy drainage and access of air. The nitrifiable solution should be applied regularly at stated intervals. This may be done automatically by the aid of a self-starting syphon.

The nitrifiable solution should be weak at the start, as the multiplication of organisms is much weaker with strong solutions.

The sprinkling can be done at first with solutions containing ·4 oz. of ammonium sulphate, at the rate of 35 gallons per cubic yard of peat per twenty-four hours. As soon as the nitrification of liquids collected at the lower end is complete—that is when they are free from ammonia or nitrates—it can be successfully carried to ·8 oz., and later to 1·2 oz. This period of starting should take a month. After this, the nitre bed works regularly, and the volume of liquid daily sprinkled—containing 1·2 oz. of ammonium sulphate—may reach 175 gallons per cubic yard of peat.

The nitrified liquids are rather poor in nitrates. To enrich them, a series of peat beds will have to be established to take the nitrified solutions of the preceding ones, with addition of a new quantity of ammonium sulphate.

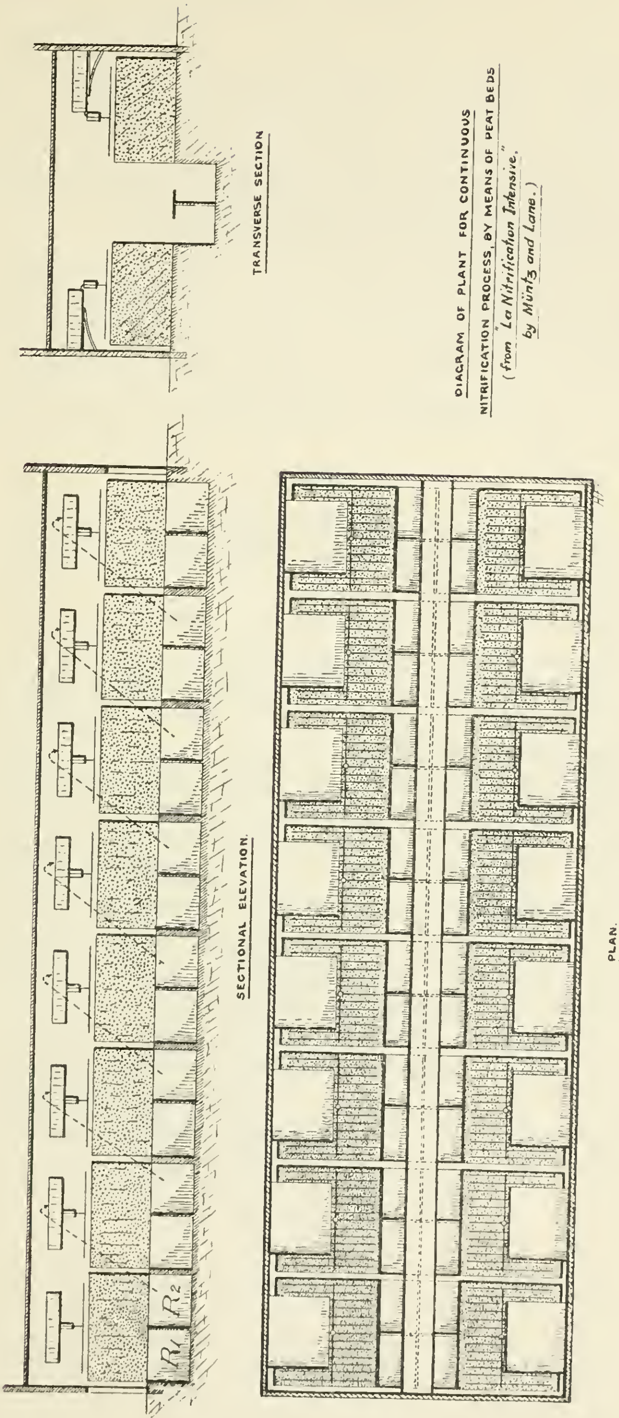

DIAGRAM OF PLANT FOR CONTINUOUS NITRIFICATION PROCESS, BY MEANS OF PEAT BEDS
(from "La Nitrification Intensive," by Müntz and Lane.)

The diagram (p. 97) shows an installation of eight nitrifying beds. Below each one are two tanks or cisterns, respectively R_1 and R_2, to receive the liquids draining from the beds. When one of these reservoirs, say R_1, is full, 10·01 pounds of ammonium sulphate per 150 gallons of liquid is added, and dissolved by stirring. This produces an abundant precipitate of sulphate of lime, owing to the presence of the nitrate of lime. After settlement, the liquid is tapped into the second compartment, R_2, and only clear liquids are pumped into the upper tank, thus protecting the nitre beds from the clogging which the sulphate of lime would produce in them.

The carbonate of lime is gradually used up, and has to be replaced. This can be done by throwing on the surface of the nitre beds a slime of pulverized chalk. The proportion of chalk thus introduced should be double the quantity of ammonium sulphate. The nitre beds will be established in buildings where a temperature of 79° or 80° can be maintained.

To operate on a large scale would, of course, require the installation of pumps, etc., to handle the liquids.

CONCLUSIONS.

From the preceding pages it is seen that peat constitutes a nitrifying medium, or support, superior to all others, either for the installation of intermittent nitre beds, or of continuously producing plants.

Peat constitutes a fuel of a very low market price at the bog, and can be utilized to maintain the necessary heat, and steam for the plant.

Moreover, owing to the high proportion of nitrogen which it contains, and which can be recovered in the form of ammoniacal salts, peat can supply the raw materials necessary for the manufacture of nitrates.

This manufacture can, therefore, rely wholly for supplies on the exploitation of peat bogs; and to avoid transportation of material which has only a small market value, the nitrifying beds should if possible be installed on the bogs themselves.

An idea might be formed of the potentiality of such deposits by presenting a few figures. A bog with a superficies of 2,500 acres, and a mean depth of six feet, with a content of two per cent in nitrogen, could yield between 800,000 and 900,000 tons of nitrate of sodium. If we take into consideration the area of the peat bogs existing in France, these figures can safely be multiplied by 300 or 400. This is a reserve of nitrogen which would meet the wants of centuries to come.

Returning to the thought which first induced the undertaking of these studies, it is seen that in case France should be unable to obtain its supply of nitrates from the deposits of Chili, or India, the installation of nitre beds would enable it to produce all the nitre necessary for the manufacture of its explosives, and war ammunition.

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REPORTS.

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2. Great Landslide at Frank, Alta. Report on—by R. G. McConnell and R. W. Brock, M.A., 1903.
3. Investigation of the different electro-thermic processes for the smelting of iron ores, and the making of steel, in operation in Europe. Report of Special Commission—By Eugene Haanel, Ph.D., 1904. (Out of print.)
4. Rapport de la Commission nommée pour étudier les divers procédés électro-thermiques pour la réduction des minerais de fer et la fabrication de l'acier employes en Europe. (French Edition), 1905. (Out of print.)
5. On the location and examination of magnetic ore deposits by magneto-metric measurements. Eugene Haanel, Ph.D., 1904.
7. Limestones, and the Lime Industry of Manitoba. Preliminary Report on—by J. W. Wells, 1905.
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16. Experiments made at Sault Ste. Marie, under Government auspices, in the smelting of Canadian iron ores by the electro-thermic process. Final Report on—by Eugene Haanel, Ph.D., 1907.

17. Mines of the Silver-Cobalt Ores of the Cobalt district: Their Present and Prospective Output. Report on—by Eugene Haanel, Ph.D., 1907.
18. Graphite, its Properties, Occurrence, Refining and Uses—by Fritz Cirkel, M.E., 1907.
19. Peat and Lignite: Their Manufacture and Uses in Europe—by Erik Nyström, M.E., 1908.

IN PRESS.

20. Iron Ore Deposits of Nova Scotia. Report on (Part I)—by Dr. J. E. Woodman.
21. Summary Report of Mines Branch, 1907-8.
22. Iron Ore Deposits of Thunder Bay and Rainy River districts. Report on—by F. Hille, M.E.
23. Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers. Report on—by Fritz Cirkel, M.E.
24. General Report on the Mining and Metallurgical Industries of Canada, 1907-8.

IN PREPARATION.

Chrome Iron Ore Deposits of the Eastern townships. Monograph on—by Fritz Cirkel, M.E.

Iron Ore Deposits of Vancouver and Texada islands. Report on—by Einar Lindeman, M.E.

MAPS.

6. Magneto-metric Survey of Calabogie mine, Bagot township, Renfrew county. Vertical Intensity—by Eugene Haanel, Ph.D., and E. Nyström, M.E., 1904.
13. Magneto-metric Survey of the Belmont Iron mine, Belmont township, Peterborough county, Ontario—by Eugene Haanel, Ph.D. Surveyed by B. F. Haanel, B.Sc., 1905.
14. Magneto-metric Survey of the Wilbur mine, Lavant township, Lanark county, Ontario—by Eugene Haanel, Ph.D. Surveyed by B. F. Haanel, B.Sc., 1905.
15. Magneto-metric Survey of Iron Ore Deposits at Austin brook, Bathurst township, Gloucester county, N.B. Vertical Intensity—by Eugene Haanel, Ph.D. Surveyed by E. Lindeman, M.E., 1906.

NOTE.—All applications for Reports, or Maps issued by the Mines Branch of the Department of Mines, must be addressed to

EUGENE HAANEL, Ph.D.,
Director of Mines,
Ottawa.

DEPARTMENT OF MINES

MINES BRANCH.

Mineral Production of Canada, Calendar Years 1895 to 1906.

PRODUCTS.		1895. Quantity.	1895. Value.	1896. Quantity.	1896. Value.	1897. Quantity.	1897. Value.	1898 Quantity.	1898 Value.
METALLIC			$		$		$		$
Antimony ore	Tons.							1.344	20.000
Copper (c)	Lbs.	7.771.639	836.228	9.393.012	1.021.960	13.300.802	1.501.660	17.747.136	2.134.980
Gold (d)	Ozs.	100.806	2,063.674	133.274	2.754.774	291.582	6.027.016	666.445	13.775.420
Pig iron (n)	Tons.								
Iron ore (a)	"	102,797	238,070	91,906	191,557	50,705	130,290	58.343	152.788
Lead (e)	Lbs.	16,461,794	531,716	24.199.977	721,159	39.018.219	1,396,853	31,915,319	1,206,399
Mercury	"	5.431	2.343	4,437	1,940	688	324		
Nickel (f)	"	3,888,525	1,360,984	3,397,113	1,188,990	3.997.647	1,399.176	5.517.690	1,820,838
Platinum	Ozs.		3.800		750		1.600	100	1,500
Palladium	"								
Cobalt	Lbs.								
Silver	Ozs.	1.578.275	1.030.299	3.205.343	2.149.503	5.558.446	3,323,395	4,452,333	2,593,929
Zinc	Lbs.							788,000	36,011
Total value, Metallic			6.087.114		8.030.633		13,780.314		21,741,866
NON METALLIC.			(a)		(a)		(a)		(a)
Actinolite	Tons.					* 205	* 1,845		
Arsenic (white)	"								
Asbestos	"	8,766	368,175	12.250	429.856	30.442	445.368	23,785	491.197
Asbestic	"								
Chromite	"	3.177	41.300	2,342	27,000	2.637	32.474	2,021	24,252
Coal (g)	"	3,478,344	6,739,153	3.746.716	7.226.462	3.786.107	7.303.597	4.173.108	8.224.288
Corundum	"								
Feldspar	"		(k) 2,545	972	(k) 2.583	1.400	3.290	2.500	6.250
Fire clay	"	1.329	3.492	842	1,805	2.118	5.759	670	1,680
Graphite	"	220	6.150	139	9.455	436	16.240		13,698
Grindstones	"	3,475	31,932	3.713	33.310	4.572	42.340	4.935	44.775
Gypsum	"	226.178	202.608	207,032	178,061	239.691	244.531	219,256	232,515
Limestone for flux	"	34,579	32,916	37.462	36.140	31,273	30,258	33.913	31.163
Lithographic stone	"		2,000						
Manganese ore	"	125	8.464	123½	(k) 3,975	15¼	1,166	50	1.600
Mica	Lbs.		65.000		60,000		76,000		118.375
Mineral pigments—									
Baryta	Tons			145	715	571	3.060	1.125	5.533
Ochres	"	1.339	14.600	2.362	16.045	3.905	23.560	2,226	17,450
Mineral waters	Gals.	739,382	126,048	706,372	111,736	749.691	141.477	555,000	100,000
Molybdenite	Lbs.								
Moulding sand	Tons.	6.765	13.530	5,739	11,471	5,485	10,931	10.572	21.038
Natural gas			423.032		276,30[illegible]		325.873		322,123
Peat	Tons.								
Petroleum (h)	Bls.	726,138	1,086.738	726.822	1.155.647	709,857	1,011,546	768.391	1.061.747
Phosphate (Apatite)	Tons	1,822	9,565	570	3,42[illegible]	908	3.984	733	3,665
Precious stones									
Pyrites	Tons	34,108	102,594	33,715	101,155	38.910	116.730	32,218	128.872
Quartz	"			10	50			284	570
Salt	"	52,376	160,455	43,960	169,693	51.348	225.730	57.142	248.639
Soapstone	"	175	2.138	410	1,23[illegible]	157	350	405	1.000
Structural materials and clay products—									
Bricks	M	308,836	1,670,000		1,600,000		† 1,600,000		1.900.000
Building stone	Cub. yd.		1,095,900		1,000,000		† 1,000,000		1.300.000
Cement, natural	Bls.			70.705	60.500	85.450	65.893	87.125	73.412
" Portland	"	128.294	173.675	78.365	141.151	119.763	209.380	163.084	324.168
Flagstones	Sq. ft.	80,005	6.687		6.710		7.190		4,250
Granite	Tons.	19.238	84,838	18,717	106.709	10,345	61,934	23.897	81.073
Lime	Bush.	5,225,000	700,000		650,000		† 650,000		†650,000
Marble	Tons.	200	2.000	224	2.405				
Pottery			151,588		163.427		129,629		214.675
Roofing cement	Tons.		3,153	86	430				
Sands and gravels (k)	"	277,102	118.359	224,769	80,110	152,963	76,729	165.954	90.498
Sewer pipe			257.045		153,875		164.250		181.717
Slate	Tons		58,900		53,370		42,800		40,791
Terra cotta			195.123		83,855		155.695		167.902
Tiles	M.	19.200	210.000		225.000		† 225,000		†225,000
Talc	Tons.								
Tripolite	"			664	9.960	15	150	1.017	16.660
Total structural materials and clay products			4,726,368		4,327,542		4.388.550		5,270.146
All other non-metallic			9,442,435		9.866.081		10.066.109		11,100.420
Total value, non-metallic			14,168,803		14.183.623		14 454.669		16.370.566
" metallic			6.087.114		8.030.633		13.780.314		21.741.865
Estimated value of products unspecified or not reported (m)			†250,000		†250,000		† 250,000		300.000
Grand total			20.505.917		22.474.256		28.485.023		38.412,431

PRODUCTS.	1899. Quantity.	1899. Value.	1900. Quantity.	1900. Value.	1901. Quantity.	1901. Value.	1902. Quantity.	1902. Value.
METALLIC		$		$		$		$
Antimony ore								
Copper (c)	15,078,475	2.655.319	18.937.138	3.065.922	37.827.018	6.096.581	38,804,259	4,511,383
Gold (d)	1,028,620	21,261,584	1.350.176	27.908.153	1,167,320	24,128,503	1,032,253	21,336,667
Pig iron (n)			35,387	583,158	83,100	1.212.113	71,664	1,043,007
Iron ore (a)	74,617	240,542	(o) 50,657	126,642	(o) 157,033	392,582	(o) 278,339	695,847
Lead (e)	21,862,436	977,250	63.169.821	2,760,521	51,900,958	2,249,387	22,956,381	934,095
Mercury								
Nickel (f)	5,744,000	2,067,840	7,080.227	3.327.707	9,189,047	4.594.523	10,693,410	5,025,903
Platinum	55	825				457	2,385	46.502
Palladium							4,411	86,014
Cobalt								
Silver	3,411,644	2,032,658	4.468.225	2.740.362	5,539,192	3,265,354	4,291,317	2,238,351
Zinc	814.000	46,805	212,800	9,342			142,200	6.882
Total value, Metallic		29,282,823		40,521.807		41.939.500		35,924,651
NON METALLIC.		(a)		(a)		(a)		(a)
Actinolite	57	4,872	303		521	3.126	550	4,400
Arsenic (white)				22.725	694	41.676	800	48,000
Asbestos	25,536	485,849	29.141	748.431	40.217	1.259.759	40,416	1,148,319
Asbestic								
Chromite	2,010	21,842	2.335	27.000	1,274	16,744	900	13,000
Coal (g)	4,925,051	10.283,497	5.777.319	13.742.178	6.486,325	12,699,243	7,466.681	15,210,877
Corundum			3	300	444	53.115	768	84.465
Feldspar	3,000	6,000	318	1,112	5.350	10,700	7,576	15,152
Fire clay	599	1,295	1.245	4.130	3,979	5.920	2,741	4,283
Graphite	1,310	24,179	1.922	31,040	2.210	38.780	1,095	28,300
Grindstones	4,511	43,265	5.539	63.450	4,581	45,690	6,433	49,118
Gypsum	244,566	267,329	252.101	259.009	293.799	340,148	332,045	359 277
Limestone for flux	51,826	44,286	52,966	39,332	169,399	183,162	293,594	219 295
Lithographic stone								
Manganese ore	1,581	20,004	30	1,800	440	4.820	172	4,062
Mica		163,000		166.000		160,000		135,904
Mineral pigments—								
Baryta	720	4,402	1.337	7,605	653	3,842	1,096	3.957
Ochres	3,919	20,000	1,966	15,398	2,233	16,735	4,955	30.495
Mineral waters		† 100,000		75,000		100,000		† 100,000
Molybdenite								
Moulding sand	13,724	27,430	6,181	12,316	14.705	29.410	13,352	27,651
Natural gas		387,271		417.094		339,476		195,992
Peat			400	1.200	220	660	475	1,663
Petroleum (h)	808,570	1,202,020	710,498	1,151,007	622,392	1,008,275	530,624	951,190
Phosphate (Apatite)	3,000	18,000	1,415	7,105	1,033	6,280	856	1,953
Precious stones								
Pyrites	27,687	110,748	40.031	155.164	35,261	130,544	35,616	138,939
Quartz	600	1,260						
Salt	59,339	254,390	62.055	279.458	59,428	262,328	64,456	292,581
Soapstone	450	1.960	420	1,365				
Structural materials and clay products—								
Bricks		2,195,000		2,275,000		2.400.000		2.593,000
Building stone		1,500,000		1.520.000		1.650.000		1,900,000
Cement, natural	141,387	119,308	125,428	99,994	133.328	94,415	127,931	98,932
" Portland	255,366	513,983	292,124	562.916	317.066	566,615	694,594	1,028,618
Flagstones		7,600		5,250		4,575	87,300	7,760
Granite	13,418	90,542		80,000		155.000		210,000
Lime		800,000		†800,000		630,000		892,000
Marble								
Pottery		185,000		200,000		†200,000		† 200,000
Roofing cement								
Sands and gravels (k)	242.450	101.640	197,558	101.666	197,302	117,465	159,793	119,120
Sewer pipe		161,546		231,525		248.116		301,965
Slate		33,406		12,100	715	9,980		19,200
Terra cotta		220,258		259.450		278.671		276,241
Tiles		† 225,000		†225,000		250,000		† 250,000
Talc			1,000	5.000	259	842	689	1.804
Tripolite	1,000	15,000	336	1,950			1,052	16,470
Total structural materials and clay products		6,168,283		6,372.901		6,803.836		7,896,836
All other non-metallic		13,482,899		17,225.975		16,761,275		19,090,147
Total value, non-metallic		19,651,182		23.598.878		23,565,111		26,988,989
" metallic		29,282,823		40.621.807		41.939.500		35,924,651
Estimated value of products unspecified or not reported (m)		† 300,000		†300,000		† 300,000		† 300,000
Grand total		49,234,005		64,420.983		65.804.611		63,211,634

PRODUCTS.	1903. Quantity.	1903. Value.	1904 Quantity.	1904 Value.	1905. Quantity.	1905. Value.	1906. Quantity.	1906. Value.	PRODUCTS.
METALLIC		$		$		$		$	METALLIC.
Antimony ore					527		782		Antimony ore.
Copper (c)	42.684.454	5.649.487	41,383,722	5,306,635	46,092,753	7,497,660	55,609,888	10,720,474	Copper (c).
Gold (d)	911,039	18,843,590	796,445	16,462,517	685,012	14,159,195	556,464	11,502,120	Gold (d).
Pig iron (n)	42,052	707,838	68.297	1,007.864	68,170	1,032,116	104,660	1,856,516	Pig iron (n)
Iron ore (a)	(o) 153,513	384,927	(o) 87,000	174,000	(o) 117,000	175,500	74,778	149,177	Iron ore (a).
Lead (e)	18,139,283	768,562	37.531,244	1,617.221	56,864.915	2,676,632	54,608,217	3,089,187	Lead (e).
Mercury									Mercury.
Nickel (f)	12.005.510	5,002,204	10,547,883	4,219,153	18,876,315	7,550,526	21,490,955	8,948,834	Nickel (f).
Platinum	1,710	33,345	571	10,872		500			Platinum.
Palladium	3,177	61,952	952	18,564					Palladium.
Cobalt			58,000	36,620	240,000	100,000			Cobalt.
Silver	3,198,581	1,709,642	3,577.526	2,047.095	5,889.667	3,614.863	8,473,379	5,659,455	Silver.
Zinc	900,000	48.600	477,568	24,356	(p) 9,413	139.200	(p) 1,154	23,800	Zinc.
Total value, Metallic		33,210,147		30,924,897		36.946.212		41,949,563	Total value, Metallic.
NON METALLIC.		(a)		(a)					NON-METALLIC.
Actinolite	†350	3,108							Actinolite.
Arsenic (white)	257	15,420	72	903	549	2,693	201	14,058	Arsenic.
Asbestos	41.677	929,757	35,611	1,213,502	50.669	1,486.359	60,761	2,036,428	Asbestos.
Asbestic			12.854	12,850	17,594	16.900	21,424	23,715	Asbestic.
Chromite	3.509	51,129	6,074	67,146	8.575	93.301	9,035	91,859	Chromite.
Coal (g)	7,960.364	15.942.833	8,254,595	16,592,231	8.667.948	17.520.263	9,762,601	19,732,019	Coal (g).
Corundum	970	80,180	993	109,545	1.644	149.153	2,274	204,973	Corundum.
Feldspar	13,928	18,966	11,083	22,166	11.700	23.400	16,948	40,890	Feldspar.
Fire clay	2,639	3,523	1,997	8,592	5,088	13,917	6,559	18,522	Fire-clay.
Graphite	728	23,745	452	11,760	541	16,735	387	16,300	Graphite.
Grindstones	5,538	48,302	4,649	42,782	5.540	62,375	5,363	59,814	Grindstones.
Gypsum	314,489	388.459	345,961	373,474	442.158	586.168	469,022	643,294	Gypsum.
Limestone for flux	277,452	249.251	211,278	177,695	309.405	235.108	331,059	248,776	Limestone for flux.
Lithographic stone									Lithographic stone.
Manganese ore	91	2,775	66	2,740	22	1,720	93	925	Manganese ore.
Mica		177.857	439	160,777		178.235	574	303,913	Mica.
Mineral pigments—									*Mineral pigments.*
Baryta	1,163	3,931	1,382	3,702	3.360	7.500	4,000	12,000	Baryta.
Ochres	6,266	32.760	3,925	24,095	5.105	34.675	6,758	36,125	Ochres.
Mineral waters		† 100,000		† 100,000		† 100,000		†100,000	Mineral waters.
Molybdenite									Molybdenite.
Moulding sand	3,658	7.256	3,423	6,790					Moulding sand.
Natural gas		202.210		328,376		379,561		583,523	Natural gas.
Peat	1.100	3.300	800	2,400	80	200	474	1,422	Peat.
Petroleum (h)	486,637	1,048.974	503,474	935,895	634.095	856,028	569,753	761,760	Petroleum (h).
Phosphate (Apatite)	1,329	8,214	817	4,590	1.300	8.425	850	6,375	Phosphate (Apatite).
Precious stones									Precious stones.
Pyrites	33,982	127,713	37,180	134,033	33,330	125,486	42,743	169,990	Pyrites.
Quartz							48,376	65,765	Quartz.
Salt	62,452	297.617	69.477	321,778	67,340	320,858	76,762	329,130	Salt.
Soapstone									Soapstone.
Structural materials and clay products—									*Structural materials and clay products.*
Bricks		2.832,000		2,983,200		3.933.925	523,390,152	4,102,590	Bricks.
Building stone		1.975,000		1,930,000		1,830,000		† 1,830,000	Building stone.
Cement, natural	92,252	74,655	56,814	50,247	14,184	10,274	8,610	6,052	Cement, natural.
" Portland	627.741	1,150.592	910,358	1,287,892	1.346.548	1,813,740	2,118,764	3,164,807	" Portland.
Flagstones	73,200	6,688	8,400	6,720		7,650	6,600	5,280	Flagstones.
Granite		200,000		150,000		226.305		278,419	Granite.
Lime		860.000		740,000		750,000	5,230,406	1,009,177	Lime.
Marble									Marble.
Pottery		+ 200,000		140,000		120,000		150,000	Pottery.
Roofing cement									Roofing cement.
Sands and gravels (k)	355,792	124.006	399,809	129,803	306,935	152.805	336,550	139,712	Sands and gravels (k).
Sewer pipe		317.970		440,894		382,000		530,045	Sewer pipe.
Slate		22,040	5,277	23,247		21,568	5,406	24,446	Slate.
Terra cotta		405.786							Terra cotta.
Tiles		275.000		260,000		+ 260,000		290,000	Tiles.
Talc	990	2.739	840	1,875	500	1,800	1,234	3,030	Talc.
Tripolite	835	16.700	320	6,400	200	3,000			Tripolite.
Total structural materials and clay products		8.443.747		8,182,103		9,608,267		11,530,528	Total structural materials and clay products.
All other non-metallic		19.786.619		20,666,897		22,224.520		25,506,606	All other non-metallic.
Total value, non-metallic		28.230.366		28,849.000		31.832,787		37,037,134	Total value, non-metallic.
" metallic		33,210,147		30,924,897		36.946.212		41,949,563	" metallic.
Estimated value of products unspecified or not reported (m)		† 300,000		† 300,000		† 300,000		† 300,000	Estimated value of products unspecified or not reported (m).
Grand total		61,740,513		60,073,897		69.078.999		79,286,697	Grand total.

(a) Value at mine, quarry or works.
(b) Not reported.
(c) Copper contents of ore, matte, etc., at the average market price for the year.
(d) Ounces, fine, calculated at value of $20.67 per oz.
(e) Lead contents of ore, matte, etc., at average market price for year.
(f) Nickel " "
(g) Includes coal used in making coke. For coke production see article on coal and coke.
(h) Crude oil calculated from official inspection returns up to end of 1900; figures for 1901, 1902, 1903, and 1904 represent sales of crude oil. Figures for 1905 and 1906 are computed from the amount of bounty paid. Values computed at average yearly price per barrel (of 35 Imp. gallons).

(k) Exports only.
(m) Mostly structural materials.
(n) Pig iron from Canadian ore only. Previous to 1900 the production of iron has been entered as ore; the figures for pig iron for these years are given, however, in the body of the report.
(o) Figures for 1900, 1901, and 1902 represent the excess of the total production of iron ore in Canada over the quantity of Canadian ore used in Canadian furnaces. Figures for 1903, 1904, and 1905 represent estimated exports. The figures of exports for these six years, as published by the Department of Customs, are believed to be overstated.
(p) Zinc ore, in tons.

NOTE.—The above figures represent the summary statements incorporated in the annually issued reports of the Section, those for the earlier years being corrected and revised to make the method of statement conform with that adopted for recent years.
The differing type shows the increases, decreases, etc., as compared with the previous year, as follows:—Heavy faced type, increase; ordinary type, decrease; ordinary type with †, same as previous year; ordinary type with *, neither increase nor decrease to record, the figures for previous year not being available.

CANADA

DEPARTMENT OF MINES

MINES BRANCH

Hon. W. Templeman, Minister; A. P. Low, LL.D., Deputy Minister;
Eugene Haanel, Ph.D., Director.

ANNUAL REPORT

ON THE

MINERAL PRODUCTION OF CANADA

During the Calendar Year

1906

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1909

[No. 26b—1908]

No. 26.

Dr. Eugene Haanel,
Director of Mines,
Ottawa.

Sir,—I beg to hand you herewith, the annual report, giving complete and revised information descriptive of the mineral production in Canada during the calendar year ending December 31, 1906. Much of the material presented herewith has already appeared in other forms, a preliminary statement of the mineral production during 1906 having been compiled and issued early in March 1907.

Owing to the fact that mining companies frequently do not know the actual results of production until several months after the ore is shipped, and to the difficulties incidental to the obtaining of information through correspondence, it naturally follows that complete data relating to the mineral industries cannot be obtained until well on in the year following that dealt with, so that the issue of the final report is necessarily delayed. In the present instance, however, the delay has been regrettably prolonged.

Mr. Ingall, formerly in charge of the Mines Section of the Geological Survey, was absent on sick leave during the first half of the year following the period dealt with herein, and on June 19, the work of the Division was transferred to the Mines Branch of the newly organized Department of Mines. Mr. Ingall relinquished his position as officer in charge of the Section, and was transferred to field duties in the Geological Survey Branch, while Mr. Denis was detached, to take charge of the collection of coal samples for the work of investigation of fuels by the Mines Branch.

In addition to the collection of the material, the compilation of the statistics, and the preparation of the reports of the Section, the staff has been kept busy in many other kindred directions, such as answering numerous inquiries, both through correspondence and in person regarding the mineral resources, and the mining and metallurgical industries of the Dominion, as well as in collecting, filing, and indexing all available information regarding the same. The checking of the reports from the assay office at Vancouver has also been added to the duties of the Division.

The desirability of improving and increasing the scope of the statistical work, and the necessity—for that purpose—of increasing the present depleted staff, have been clearly set forth in your Summary

Report on the work of the Mines Branch for the fiscal year 1907–8, and need not be further referred to, except to reiterate the necessity of having officers permanently attached to the Department to carry on, and keep up to date the work indicated in the general report on the Mining and Metallurgical Industries of Canada (No. 24)—now in the press.

I am, Sir,

Your obedient servant,

JOHN McLEISH.

Division of Mineral Resources and Statistics,
Ottawa, July 23, 1908.

EXPLANATORY NOTES.

YEAR AND TON USED.

The year referred to throughout this report is the calendar year, except for the figures of imports, which refer to the fiscal year ending June 30. The ton is that of 2,000 pounds, unless otherwise stated.

EXPORTS AND IMPORTS.

The figures given throughout the report referring to exports and imports are compiled from data obtained from the reports of the Customs Department, and will occasionally show discrepancies, which, however, there are no means of correcting.

The exports and imports formerly entered under the headings of each province did not necessarily represent the production or consumption of the province; e.g., material produced in Ontario was often shipped from Montreal and entered there for export, so falling under the heading, Quebec.

NOTE.—N.E.S. = Not elsewhere specified.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this Department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year in the New York market. Spot values have been adopted for the figures of production of the non metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential, unless otherwise arranged with those interested. The confidence of the mining community, thus gained, has resulted in an increasingly general response to our circulars, although, to complete our data, personal application is still advisable in a few instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

The figures given throughout the report are based as far as possible upon returns obtained direct from the various operators, or from official data, and the totals are checked by comparison with railway shipments, exports, and all other available sources of information. It can be, therefore, fairly claimed that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures entries are made, as a rule, by those having no technical knowledge of mineral substances, and in the case of the railways but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

CORRECTIONS—ALTERATIONS.

Corrections and alterations have been made throughout this report wherever they seemed to be called for, according to more complete and reliable data, available since previous issues.

The tabulated statement given in the folded sheet at the beginning of the report represents a compilation of all the similar statements found in previous reports, re-modelled and further revised wherever possible.

INTRODUCTION.

It can truly be said that the condition of the mining industry in Canada in 1906 was one of great prosperity, and that it, in fact, achieved greater progress, and gave bigger results, than during any previous year on record. In 1905, the total mineral output in Canada aggregated $69,078,999, as compared with a little over $60,000,000 in 1904; but in 1906, the output reached a total value of $79,286,697, an increase of $10,207,698, or 14·7 per cent over the production of the previous year. This large increase is particularly gratifying because it occurred despite a continued falling off in the total gold output of the country. There was, during the year, an active demand for nearly all mining products, and the higher prices realized, especially for the metals and their ores, not only helped to increase the actual value of the year's output, but also greatly stimulated development and prospecting throughout the country.

The total annual mineral production since 1895 is shown in the general table (folded herewith). The value of the production in 1895 was $20,505,917. A steady annual increase in production is shown during the following years, until a maximum output of $65,804,611 was reached in 1901. The next three years showed slight decreases, until in 1904 the production had fallen to $60,073,897. The next year, however, a large increase placed the output beyond the former high mark, followed by a still larger increase in 1906.

Examining the statistics of production during the year under review, in detail, we find that $41,949,563, or 52·9 per cent of the total value, is to be attributed to the value of the metals contained in the metallic ores shipped; $37,037,134, or 46·7 per cent of the total value, was contributed by the non-metallic minerals, of which $11,530,528 represented the value of the structural or building materials and clay products, and $25,506,606 the value of the minerals such as coal, asbestos, gypsum, petroleum, natural gas, etc., etc. The relative importance in value of output of the different items contributing to the total mineral production is shown in the following table, entitled ' Proportionate value of different mineral products."

PROPORTIONATE VALUE OF DIFFERENT MINERAL PRODUCTS, 1906.

Products.	Contributing over 15 p. c.	Contributing between 10 p. c. and 1 p.c.	Contributing under 1 p. c.
1 Coal	24·88		
2 Gold	14·51		
3 Copper	13·52		
4 Nickel	11·28		
5 Silver	....	7·14	
6 Bricks	....	5·17	
7 Portland cement	....	3·99	
8 Lead	....	3·89	
9 Asbestos and Asbestic	....	2·59	
10 Pig iron	....	2·35	
11 Building stone	....	2·31	
12 Lime	....	1·27	
13 Petroleum	....	....	0·96
14 Gypsum	....	....	0·81
15 Natural gas	....	....	0·74
16 Sewer pipe	....	....	0·66
17 Salt	....	....	0·42
18 Mica	....	....	0·38
19 Tiles	....	....	0·36
20 Granite	....	....	0·35
21 Limestone for flux	....	....	0.32
22 Corundum	....	....	0·25
23 Sundry under 1 p. c.	....	....	1·85
Total	64·19	28·71	7·10

It will be observed that nearly one-fourth of our total mineral production is to be attributed to the mining of coal. Gold, which in 1903 and several preceding years occupied first place in point of value, contributed about 14½ per cent of the total, and is closely followed by copper with 13½ per cent, and nickel over 11 per cent; while silver and lead together, accounted for about 11 per cent of the total.

To the metallic ores, together with the fuels, therefore, is to be credited over 79 per cent of our total output. The relative importance of the other items is clearly set forth in the table, and does not require special reference except as regards pig iron. From a metallurgical point of view, the production of pig iron is a much more important industry than is here set forth, ranking probably in second place, but as a large proportion of the iron is made from imported ore, only that quantity that can be attributed to Canadian ore has been included in these general tables.

Comparing the mineral production in 1906 with the production in 1905, large increases are shown in nearly all the important mineral products, the chief exceptions being gold, lead with a decreased output though a higher aggregate value, and petroleum. Thirteen items show a total increase of $12,292,040, and four items a decrease of $2,870,965. These are shown in tabular form as follows, while in a separate table the percentage increases or decreases in both quantity and value are shown.

INCREASES AND DECREASES IN VALUE OF PRODUCTION IN 1906 AS COMPARED WITH 1905.

Products.	Increases.	Decreases.
	Value	Value.
Copper	$3,222,814	
Gold		$2,657,075
Pig iron (from Canadian ore)	824,400	
Lead	412,555	
Nickel	1,398,308	
Silver	2,044,572	
Zinc		115,400
Asbestos and asbestic	556,884	
Coal	2,211,756	
Corundum	55,820	
Gypsum	57,126	
Natural gas	203,962	
Petroleum		94,268
Pyrites	44,504	
Salt	8,272	
Cement, natural		4,222
Cement, Portland	1,251,067	
Total	12,292,040	2,870,965

PROPORTIONAL INCREASES AND DECREASES OF DIFFERENT MINERAL PRODUCTS 1906–1905.

Products.	Quantity.		Value.	
	Increase.	Decrease.	Increase.	Decrease.
	p.c.	p.c.	p.c.	p.c.
Metallic:—				
Copper	15·630		43·055	
Gold		18·765		18·765
Pig iron (from Canadian ore)	53·527		79·874	
Pig iron (from both Canadian and imported ore)	13·916		22·855	
Lead		3·968	15·413	
Nickel	13·851		18·519	
Silver	41·466		56·559	
Non-metallic:—				
Asbestos and asbestic	20·394		37·045	
Coal	12·628		12·623	
Corundum	38·321		37·424	
Gypsum	6·075		9·745	
Mica			70·512	
Natural gas			53·736	
Petroleum		10·117		11·012
Salt	13·991		2·578	
Portland cement	57·422		65·372	
Granite			23·028	

An important feature of the mining industry during 1906 was the large increase in the prices of the metals during the year, as evidenced by the following quotations. The average prices of the chief metals for 1905 were as follows: silver 60·35 cents per ounce; copper 15·59 cents per pound; lead 4·7 cents per pound; spelter 5·82 cents per pound: nickel 40 cents per pound. During 1906, the prices of all these metals advanced considerably, and in December, 1906, the quotations were as follows: silver over 70 cents per ounce; copper over 22 cents per pound; lead 5·75 cents per pound; spelter 6·4 cents per pound; and nickel from 45 to 50 cents per pound. The higher prices are also clearly shown in the table of proportional increases, where it is seen that while copper increased about 15 per cent in quantity, the increase in total value was over 43 per cent. In the case of lead a decrease in quantity of nearly 4 per cent is shown, but the aggregate value increased over 15 per cent. There was an increased output of silver of 41 per cent in quantity, and over 56 per cent in value, and in nickel an increase of nearly 14 per cent in quantity and over 18 per cent in value. The largest proportional increases are shown by mica, Portland cement, natural gas, and silver.

Although the mining bureaus of several of the provinces publish very complete mining statistics, these are unfortunately neither compiled nor valued on a uniform basis, and comparisons are not easily made. The statistics of production presented herewith, however, being valued on a uniform basis for the whole of Canada, it is possible to compare the different provinces in their importance as mineral producers, and the following table is presented showing the production by provinces for the years 1905 and 1906.

MINERAL PRODUCTION BY PROVINCES 1905-1906.

Province.	1905.		1906.	
	Value of Production.	Per cent of total.	Value of Production.	Per cent of total.
	$		$	
Nova Scotia	11,507,047	16·66	12,894,303	16·26
New Brunswick	559,035	·81	646,328	0·82
Quebec	4,405,975	6·38	5,242,058	6·61
Ontario	18,833,292	27·26	25,111.682	31·67
Manitoba, Alberta, Saskatchewan and Yukon	11,387,642	16·48	10,092,726	12·73
British Columbia	22.386,008	32·41	25,299,600	31·91
Total	69,078,999	100·00	79,286,697	100·00

The principal change to be noted in 1906 compared with 1905, is the relatively larger output in the Province of Ontario in 1906, this province now having practically as large an output as British Columbia. In fact, were the production of iron in Canadian furnaces from imported ore to be included as a Canadian mineral production, the province of Ontario would undoubtedly take first place, and the relative importance of Nova Scotia would also be very considerably increased. Also the relative importance of Quebec Province would be somewhat augmented were aluminium included, of which there is a large production at Shawenegan Falls, from imported bauxite.

A very large proportion of the mineral production in Canada is exported, and the two tables following have been compiled from the Trade and Navigation reports, the first showing the exports during the calendar year, arranged by mineral products, and the second showing the exports during the fiscal year classified according to destination of shipments.

EXPORTS.

MINERALS AND MINERAL PRODUCTS OF CANADA DURING CALENDAR YEAR 1906.

Products.	Value.	Products.	Value.
Aluminium	$ 901,357	Manufactures of metals other than iron and steel.	$ 55,183
Antimony ore	17,064	Mica	581,919
Arsenic	5,981	Mineral pigments	2,379
Asbestos	1,689,257	" water	5,629
Barytes	6,750	Nickel	2,534,684
Bricks	6,541	Oil, crude	141
Cement	7,551	" refined	1,401
Clay, Mfgrs of	125	Ores unspecified	384,629
Chromite	10,188	Platinum	14,888
Coal	4,738,497	Phosphate	
Coke	168,571	Plumbago, crude	2,468
Copper	7,303,366	" mfrs. of	5,274
Feldspar	60,312	Pyrites	65,349
Gold	11,223,781	Salt	3,437
Grindstones	31,978	Sand and gravel	139,712
" rough	9,281	Silver	5,686,144
Gypsum, crude	462,814	Stone, unwrought	3,312
" ground	2,934	" wrought	24,460
Iron and steel	1,552,963	Sulphuric acid	762
Iron ore	149,177	Other articles	146,337
Lead	736,007		
Lime	57,072		
Manganese ore	925	Total	38,800,900

EXPORTS.

Destination of Mine Products during the Fiscal Year 1905-1906.

Destination.	Value.	Destination.	Value.
United States	$32,869,004	Mexico	$ 11,235
Great Britain	1,475,839	British West Indies	7,394
Newfoundland	468,383	Australia	5,927
Germany	124,257	Austria Hungary	4,950
China	114,270	Cent. Am States	2,000
Belgium	91,885	Holland	1,506
Japan	81,185	Norway	450
Bermuda	71,609	New Zealand	398
France	56,447	Hong Kong	280
St. Pierre Miquelon	26,985	British Guiana	15
Italy	24,907		
British Africa	18,452	Total	$35,469,631
Cuba	12,253		

As would naturally be expected, the first table shows that the metallic ores constitute the bulk of the exports, while the second table indicates that over 92 per cent of the total exports went to the United States, and only 4 per cent to Great Britain.

There is but one metal refinery in Canada, viz., at Trail, British Columbia, at which fine gold, fine silver and pig lead are produced; but the great bulk of the products of the metallurgical furnaces in this province are shipped to the United States for refining. In Ontario also, practically all the metallic ore production, comprising chiefly the nickel copper ores of Sudbury district, and the rich silver ores of Cobalt, though partially reduced in Canada, are ultimately exported to the United States or Great Britain for refining. So also many of the non-metallic minerals, asbestos, gypsum, mica, corundum, are largely exported.

Statistics of imports of minerals and mineral products during the fiscal year ending June 30, 1906, compiled from the same source. are shown in the last table.

Since we export practically all our metallic ores, it naturally follows that we are compelled to import a large value in metals and their manufactures. Thus we find that in 1905-06, out of a total importation of minerals and mineral products of $89,389,504, iron and steel and their manufactures make up over 43 millions, while coal and coke account for another 20 millions. Copper, gold, lead, brass, tin, zinc, and their manufactures, make up nearly ten millions more.

IMPORTS.

Mineral and Mineral Products for Fiscal Year 1905-1906.

Products.	Value.	Products.	Value.
Alumina	$ 194,083	Lime	$ 93,630
Alum and aluminous cake	51,914	Litharge	39,836
Aluminium	192,044	Lithographic stone	6,772
Antimony	42,517	Manganese, oxide of	5,508
" salts	13,780	Magnesia	8,727
Arsenic	19,169	Marble and mfrs. of	189,589
Asbestos and mfrs. of	137,974	Mercury	69,505
Asphaltum	172,641	Metallic alloys—	
Bells and gongs	109,129	Babbitt metal	59,662
Bismuth	949	Brass and mfrs. of	1,785,005
Blast furnace slags	19,005	Britannia metal	40,462
Borax	78,277	German silver	84,295
Bricks and tiles	460,410	Type metal	8.675
" fire	539,962	Mineral and bituminous substances, N.O.P	77,694
Buhrstones	2,661	Mineralogical specimens	726
Cement	995,731	Mineral and metallic pigments, paints and colours	1,237,796
Chalk, prepared	32,906	Mineral water, including Aaerated water	178,639
Clays	220,504	Nickel	15,976
Coal	19,153,832	Ores of metals, N.E.S	2,270,036
" tar pitch	154,628	Paraffine wax	9,721
Coke	1,311,375	" candles	15,804
Copper and mfrs. of	3,102,157	Petroleum and products of	2,575,350
Cryolite	22,793	Phosphate (fertilizer)	20,497
Crucibles, clay or plumbago	32,950	Platinum, mfrs. of	54,494
Chloride of lime	59,315	Precious stones	1,601,545
Earthenware	1,692,359	Pumice	9,053
Electric carbons	118,757	Salt	412,019
Emery	63,861	Saltpetre	109,005
Feldspar, quartz, flint, etc	30,801	Sand and gravel	173,727
Fullers earth	4,644	Slate and mfrs. of	112,941
Fossils	15	Stone and mfrs. of	370,130
Gold and silver and mfrs. of	555,701	Sulphate of copper	95,049
Graphite and mfrs. of	55,756	" iron	2,493
Gypsum, plaster of Paris, &c	67,549	Sulphur	436,827
Iron and steel—		Sulphuric acid	8,558
Pigs, scraps, blooms, &c.	2,451,416	Tufa calcareous	30
Rolled, bars, plates, &c., including chrome steel	12,342.364	Tin and manufactures of	3,336,948
Ferro-silicon, ferro-manganese, &c	462,739	Whiting	44,876
Manufactures of, machinery, hardware, &c	27,978,941	Zinc and mfrs. of	466,627
Kainite	3,411		
Lead and mfrs. of	412,197	Total	89,389,504

PRECIOUS METALS.

Gold and Silver.

The rarer metals of the platinum group, usually included as precious metals, are considered under the general heading of miscellaneous metals.

Refined Metals :—

Previous to 1904 there was no production of refined gold or silver in Canada, the metals being shipped out of the country, either as crude bullion or contained in ore matte, regulus, or other metallurgical product.

In 1904, however, the refinery of the Canadian Smelting Works at Trail, B.C., now the Consolidated Mining & Smelting Company of Canada, Ltd., was placed in operation, and the production of gold and silver bars of a fineness of ·999 begun.

The annual production of refined gold and silver has been as follows :—

Production of Refined Gold and Silver at Trail, B.C.

Calendar Year.	Gold. Fine Ounces.	Silver. Fine Ounces.
1904	4,336	551,450
1905	8,602	1,088,328
1906	9,992·631	1,263,809·3

The production of gold and silver contained in ore, etc., is considered below under separate headings.

GOLD.

The Department is indebted to the various provincial Mining Bureaus for much of the statistical information given in the following tables, and to the Director of the United States Mint for a statement of receipts of gold at that institution, from the Canadian Yukon.

The value of the gold output in Canada in 1906 was $11,502,120, representing 556,464 fine ounces; a decrease being shown from the output in 1905 of $2,657,075, or 18·76 per cent.

The chief sources of production were the ores and placers of British Columbia and the alluvial deposits of the Yukon district, while comparatively small amounts were obtained in the other provinces. In each province or district a smaller production was made in 1906 than in 1905, the greatest falling off being from the Yukon. The gold production in Canada from 1887 to 1896 varied from a little over a million dollars to nearly three million dollars, while from 1896 to 1900, owing to the discovery and development of the Yukon district, a very rapid increase was made to $27,908,153. Since that year, however, the output from the Yukon has steadily diminished, while the British Columbia production has slowly increased, until in 1906 the output from these two sections of the country was practically the same.

Of the total output in 1906, 40·6 per cent was derived from the Yukon district, and 48·5 per cent from British Columbia; 56·9 per cent or $6,549,200 was obtained from placer and hydraulic workings, etc., and 43·1 per cent or $4,952,920 from lode mining.

Tables 1 and 2 show the yearly production from 1887 to 1906, and the production by provinces in 1906.

TABLE 1.

PRECIOUS METALS.

GOLD—ANNUAL PRODUCTION IN CANADA.

Calendar Year.	*Ounces. Fine.	Value.	Calendar Year.	*Ounces. Fine.	Value
1887	57,465	$ 1,187,804	1897	291,582	$ 6,027,016
1888	53,150	1,098,610	1898	666,445	13,775,420
1889	62,658	1,295,159	1899	1,028,620	21,261,584
1890	55,625	1,149,776	1900	1,350,176	27,908,153
1891	45,022	930,614	1901	1,167,320	24,128,503
1892	43,909	907,601	1902	1,032,253	21,336,667
1893	47,247	976,603	1903	911,639	18,843,590
1894	54,605	1,128,688	1904	796,445	16,462,517
1895	100,806	2,083,674	1905	685,012	14,159,195
1896	133,274	2,754,774	1906	556,464	11,502,120

*Calculated from the value at the rate of $20.67 per ounce.

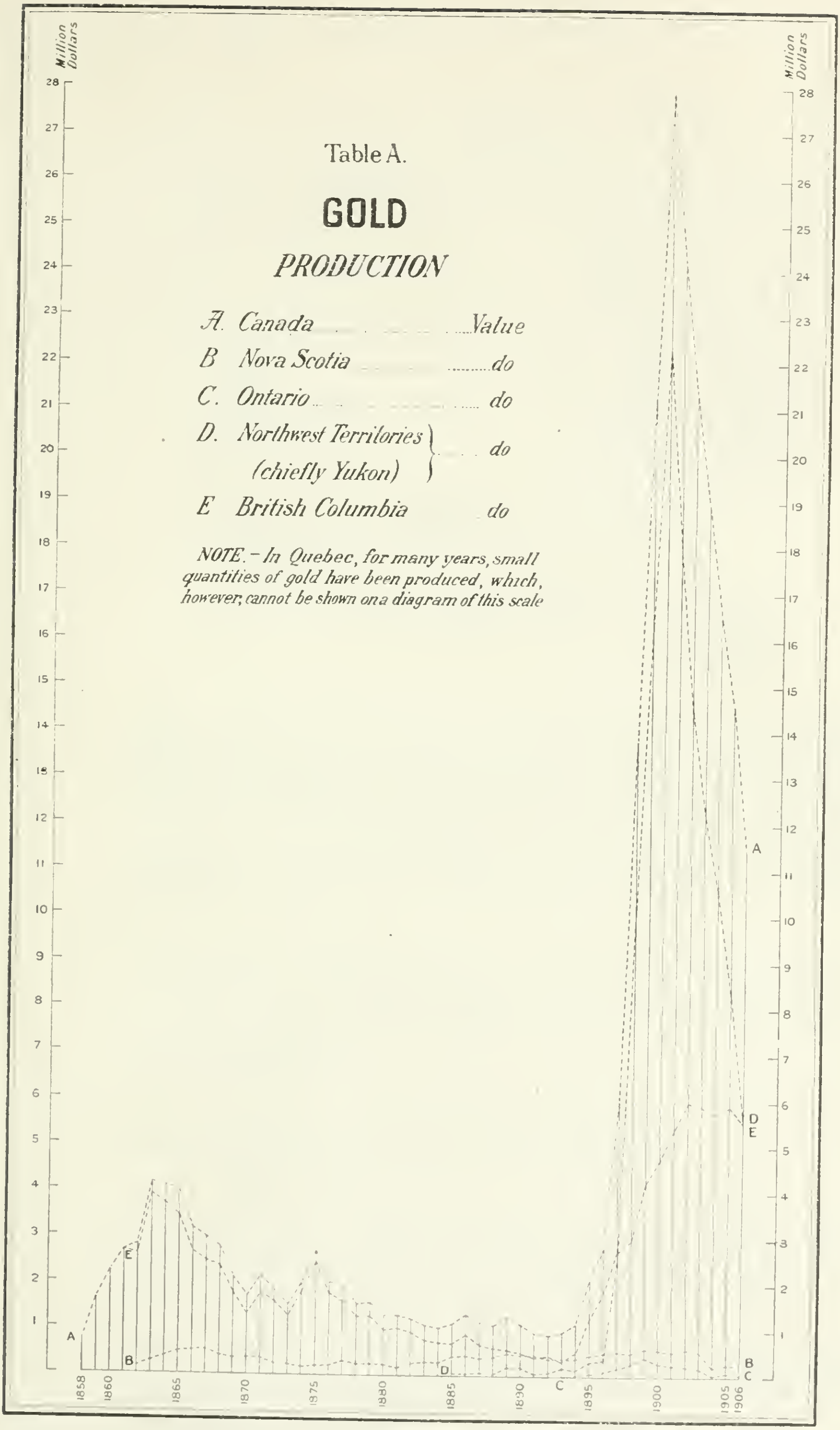


Table A.
GOLD
PRODUCTION
A. Canada ... Value
B Nova Scotia ... do
C. Ontario ... do
D. Northwest Territories (chiefly Yukon) ... do
E British Columbia ... do
NOTE. – In Quebec, for many years, small quantities of gold have been produced, which, however, cannot be shown on a diagram of this scale
Million Dollars
1858
1860
1865
1870
1875
1880
1885
1890
1895
1900
1905
1906

TABLE 2.

PRECIOUS METALS.

GOLD—PRODUCTION BY PROVINCES AND DISTRICTS, CALENDAR YEAR 1906.

Provinces.	*Ounces Fine.	Value.
Nova Scotia	(*b*) 12,224	$ 252,676
Quebec	165	3,412
Ontario	(*b*) 3,202	66,193
Alberta	(*a*) 39	800
Yukon district	(*a*) 270,924	5,600,000
British Columbia	(*c*) 269,910	5,630,639
Total	556,464	11,502,120

* Calculated from the value at the rate of $20.67 per ounce.

(*a*) Placer gold.

(*b*) Gold from vein mining.

(*c*) As follows: Gold from placer mining .... $ 948,400
" vein " 4,630,639
$ 5,579,039

Nova Scotia:—The gold output of this Province is derived almost entirely from quartz ores. In 1906, according to returns furnished by the Nova Scotia Department of Mines, there were crushed 66,059 tons of ore which yielded 13,298 ounces 14 dwts. 7 grs. of gold, valued at $252,676, an average of 4 dwts. 0·63 grains or $3.82 per ton. With the exception of the year 1904, when the output was valued at $214,209, this is the smallest production recorded since 1881.

The average output during the last three years has been less than half what it was during the previous seven years, a condition which has resulted from the closing down of one or two of the most regular and largest producers.

An examination of the records of production shows that the average value of the ore treated has been steadily decreasing.

From 1862 to 1882 the average value per ton of the yearly output ranged from $12 to over $20; from 1882 to 1890 the average varied from $11 to $15 per ton. Since 1893 the average value decreased even more rapidly, falling to $4.90 in 1905 and $3.82 in 1906.

These figures would seem to indicate the successful and profitable treatment of the low grade ores, and this is apparently evidenced in the Boston-Richardson mine.

This mine, situated at Isaac harbour, may be cited as a typical example of a profitable low grade property. At this mine there was treated during the twelve months ending September 1906, 35,220 tons of quartz ore, from which there was extracted 4,819 ounces of gold, or over one-third of the total production of the Province for the year. A sixty stamp mill has been kept in continuous operation throughout the year, and it was proposed to largely increase this plant. As an illustration of the operation of this mine, the value of the ore and the cost of mining and operating, the following abstract, taken from the monthly statement for August 1906 furnished to the provincial Department of Mines, is given.

No. of tons crushed	3,939
No. of tons concentrates produced	8.272
Value of ore per ton (determined by assay)	$ 2 94
Value of concentrates per ton	17 00
Total value recovered	2 55
Cost of operation of mine per ton	1 08
Cost of operation of mill per ton	0 19
Cost of operation of cyaniding plant per ton ore	0 10
Cost of cyaniding concentrates, per ton concentrates	4 39
General maintenance of plant	0 53
Total cost of operation per ton	1 90
Average crushing per stamp per 24 hours	298 tons.

Statistics of gold production in Nova Scotia are given in tables 3, 4, 5, and 6 following. Table 3 shows the annual gold output; table 4 the tons of quartz crushed and the average yield per ton; table 5 shows the total production of each district from 1862 to the end of 1906 as well as the average yield per ton; and table 6 shows the amount of ore crushed and its yield per district for 1906.

TABLE 3.

PRECIOUS METALS.

GOLD.—NOVA SCOTIA:—ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1862	$141,871	1885	$432,971
1863	272,448	1886	455,564
1864	390,349	1887	413,631
1865	496,357	1888	436,939
1866	491,491	1889	510,029
1867	532,563	1890	474,990
1868	400,555	1891	451,503
1869	348,427	1892	389,965
1870	387,392	1893	381,095
1871	374,972	1894	389,338
1872	255,349	1895	453,119
1873	231,122	1896	493,568
1874	178,244	1897	562,165
1875	218,629	1898	538,590
1876	233,585	1899	617,604
1877	329,205	1900	598,553
1878	245,253	1901	546,963
1879	268,328	1902	627,357
1880	257,823	1903	527,806
1881	209,755	1904	214,209
1882	275,090	1905	283,353
1883	301,207	1906	252,676
1884	313,554		

TABLE 4.

PRECIOUS METALS.

GOLD.—NOVA SCOTIA:—ORE TREATED AND YIELD OF GOLD PER TON.

Calendar Year.	Tons Treated.	Yield of Gold per ton.	Calendar Year.	Tons Treated.	Yield of Gold per Ton.
1862	6,473	$21·91	1885	$28,890	14·98
1863	17,000	16·02	1886	29,010	15·70
1864	21,431	18·21	1887	32,280	12·81
1865	24,421	20·32	1888	36,178	12·08
1866	32,157	15·28	1889	39,160	13·02
1867	31,384	16·96	1890	42,749	11·11
1868	32,259	12·41	1891	36,351	12·42
1869	35,144	19·91	1892	32,552	11·98
1870	30,824	12·56	1893	42,354	8·99
1871	30,787	12·17	1894	55,357	7·04
1872	17,089	14·94	1895	60,600	7·47
1873	17,708	13·05	1896	69,169	7·13
1874	13,844	12·87	1897	73,192	7·68
1875	14,810	14·76	1898	82,747	6·50
1876	15,490	15·08	1899	112,226	5·50
1877	17,369	18·95	1900	87,390	6·85
1878	17,989	13·63	1901	91,948	5·32
1879	15,936	16·83	1902	93,842	6·68
1880	13,997	18·42	1903	103,856	5·08
1881	16,556	12·66	1904	45,436	4·71
1882	21,081	13·04	1905	57,774	4·90
1883	25,954	11·60	1906	66,059	3·82
1884	25,186	12·44			

TABLE 5.

PRECIOUS METALS.

GOLD.—NOVA SCOTIA:—PRODUCTION OF THE DIFFERENT DISTRICTS FROM 1862 TO 1906, INCLUSIVE.

Districts.	Tons of Crushed Ore.	Total Yield.				Average Yield per ton of 2,000 lbs.
		Oz.	Dwt	Grs.	Value at $19 per Oz.	
Brookfield	98,092	43,214	2	8	$821,068	8·37
Caribou	186,847	55,622	12	5	1,056,829	5·65
Central Rawdon	13,340	10,121	11	21	192,310	14·42
Fifteenmile Stream	42,723	18,854	0	5	358,226	8·38
Lake Catcha	18,877	15,358	19	18	291,820	15·45
Malaga	24,787	17,486	12	4	332,246	13·40
Montague	27,626	40,510	2	4	769,692	27·86
Oldham	53,969	57,699	19	15	1,096,299	20·31
Renfrew	52,758	45,512	4	13	864,732	16·39
Salmon River	104,136	34,100	11	21	647,911	6·22
Sherbrooke	320,425	160,416	13	13	3,047,916	9·51
Stormont	370,739	98,292	7	11	1,867,554	5·03
Tangier	40,709	23,131	2	6	439,491	10·79
Uniacke	64,636	44,075	18	3	837,442	12·95
Waverly	155,908	70,833	12	23	1,345,839	8·63
Wine Harbour	73,019	40,659	12	3	772,532	10·57
Other Districts	140,339	86,681	8	17	1,646,947	11·73
Totals	1,788,930	862,571	11	22	16,388,854	9·16

TABLE 6.
PRECIOUS METALS.
GOLD.—NOVA SCOTIA:—DISTRICT DETAILS, CALENDAR YEAR, 1906.

Districts.	Mines	Mills.	Tons of Ore Crushed.	Total Yield of Gold.			Average Yield of Gold per Ton.		
				Oz.	Dwt	Grs.	Oz.	Dwt.	Grs.
Cariboo	4	4	10,477	836	6	22	..	1	14·31
Ecum Secum	1	1	156	135	9	0	..	17	8·77
Fifteenmile Stream	1	1	240	54	0	0	..	4	12·00
Gold River	1	2	117	256	12	0	2	3	20·72
Harrigan Cove	1	1	903	253	10	0	..	5	14·75
Lake Catcha	1	1	264	283	0	0	1	1	11·27
Lawrencetown	1	1	225	42	5	0	..	3	18·13
Leipsigate	1	1	2,297	788	12	0	..	6	20·79
Montague	1	1	97	26	11	0	..	5	11·38
Oldham	2	1	972	960	10	18	..	19	18·34
Quaddy	1	1	30	1	0	0	..	..	16·00
Renfrew	1	1	306	72	5	0	..	4	17·33
Upper Stewiacke	1	1	40	18	8	0	..	9	4·80
Sherbrooke	2	2	2,268	575	7	0	..	5	1·77
Stormont	4	4	43,465	6,734	11	11	..	3	2·37
Tangier	2	2	32	6	5	0	..	3	21·75
Uniacke	1	1	141	310	0	0	2	3	23·32
Wagamatkeek	1	1	8	3	17	12	..	9	16·50
Whiteburn	1	1	76	42	6	0	.	11	3·16
Wine Harbour	2	2	3,163	861	5	0	..	5	10·69
Mortared	......	....	(50 lbs.)	4	11	5	182	8	8·00
Stibnite ore	1	....	782	1,031	13	11	1	6	9·25
Total	31	30	66,059	13,298	14	7	..	4	0·63

Quebec:—The small production of gold credited to this Province during the past four years is almost altogether represented by the gold contents of the pyritous ores mined near Sherbrooke in the Eastern townships. A small amount of prospecting is regularly done upon the alluvial deposits of the St. Francis, Chaudière and Gilbert rivers; but very little output has been derived from this source for the past few years.

TABLE 7.
PRECIOUS METALS.
GOLD.—QUEBEC:—ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1877	$ 12,057	1892	$12,987
1878	17,937	1893	15,696
1879	23,972	1894	29,196
1880	33,174	1895	1,281
1881	56,661	1896	3,000
1882	17,093	1897	900
1883	17,787	1898	6,089
1884	8,720	1899	4,916
1885	2,120	1900	Nil.
1886	3,981	1901	3,000
1887	1,604	1902	8,073
1888	3,740	1903	3,712
1889	1,207	1904	2,900
1890	1,350	1905	3,940
1891	1,800	1906	3,412

Ontario :—"The gold mines of the Province were for the most part idle and unproductive during 1906. According to the returns made to the Bureau, some 3,926 ounces of bullion were obtained from the following properties: St. Anthony Reef, Laurentian, Sultana, Shakespeare, Olympia, Rush Bay, Golden Horn and Graig; a small amount was also recovered from the Bessemer mattes made from the nickel-copper ores raised by the Canadian Copper Company. The total value of the gold production was $66,193, a somewhat smaller yield than that for the year previous.

Gold was found in 1906 on the shores of Larder lake, which lies some distance north-east of Lake Timiskaming and near the Quebec boundary line, and the many prospectors who were attracted by reports of the discoveries staked out a large number of claims, mostly during the winter of 1906-07." (1).

A short visit was paid to the Larder Lake district by Mr. R. W. Brock in 1907 for the Ontario Bureau of Mines, and a preliminary report published in the Sixteenth Annual Report of the Bureau pages 202-218. There has as yet been no gold produced for this district.

TABLE 8.

PRECIOUS METALS.

GOLD.—ONTARIO :—ANNUAL PRODUCTION.

Calendar Year.	*Ounces. Fine.	Value.
1887	327	$ 6,760
1888	....	....
1889	....	....
1890	....	....
1891	97	2,000
1892	344	7,118
1893	708	14,637
1894	1,917	39,624
1895	3,015	62,320
1896	5,563	115,000
1897	9,158	189,294
1898	12,864	265,889
1899	20,395	421,591
1900	14,392	297,495
1901	11,845	244,837
1902	11,119	229,828
1903	9,097	188,036
1904	1,935	40,000
1905	4,403	91,000
1906	3,202	66,193

* Calculated from the value of $20·67 per ounce.

(1) Sixteenth Annual Report of the Ontario Bureau of Mines, Part I, page 6.

Alberta:—About \$800 worth of gold, derived from the placer deposits of the Saskatchewan river, was purchased by the banks at Edmonton during 1906. This is the only record of production from that district during the year.

Statistics of the production of gold from the Saskatchewan river since 1887 are shown in the following table:—

TABLE 9.

PRECIOUS METALS.

GOLD.—ALBERTA:—ANNUAL PRODUCTION.

Calendar Year.	*Ounces. Fine.	Value.
		\$
1887	102	2,100
1888	58	1,200
1889	968	20,000
1890	194	4,000
1891	266	5,500
1892	508	10,506
1893	466	9,640
1894	725	15,000
1895	2,419	50,000
1896	2,661	55,000
1897	2,419	50,000
1898	1,209	25,000
1899	726	15,000
1900	242	5,000
1901	726	15,000
1902	484	10,000
1903	48	1,000
1904	24	500
1905	121	2,500
1906	39	800

* Calculated from the value at the rate of \$20.67 per ounce.

Yukon District or Klondike:—The production of the Yukon district in 1906 is estimated at about \$5,600,000, representing 270,924 fine ounces of gold. The production in 1905 was stated in a report for that year to have been \$6,327,200. This figure represented a preliminary estimate of the receipts of United States receiving offices of gold from the Canadian Yukon. It was discovered, however, that about 24,996 crude ounces of gold dust coming from the mines of Alaska were purchased in Dawson during 1905 and wrongly credited to the Canadian Yukon. Revised figures place the receipts of Canadian Yukon gold and silver in United States receiving offices during 1905 as:—

—	Standard Ounces.	Value.
Gold	423,438·463	\$7,875,955.41
Silver	99,588·74	56,765.58

or a total output of the precious metals from the Canadian Yukon in 1905 of $7,932,720. (1)

We are indebted to the Director of the United States Mint at Washington for a statement of the amount of gold and silver deposited at the United States receiving office in 1906, as follows :—

——	Fine ounces.	Value.
Gold..........................	270,771·963	$5,596,856
Silver	63,665·49	42,522
		$ 45,639,378

The total value of the production of the precious metals in 1906, according to this authority, would be, therefore, $5,639,378.

This statement is qualified, however, by the explanation that it may possibly include some gold from United States territory in Alaska, wrongly credited to the Canadian Yukon, or gold from Canadian sources other than the Yukon.

A royalty of $2\frac{1}{2}$ p.c. is collected by the Dominion Government on the gold output from the Yukon, and on the basis of this tax the following is a statement of the monthly production of gold during 1906, as furnished by the Interior Department :—

Production of gold in the Canadian Yukon Territory, based on the amount of royalty collected during the year ending Dec. 31.

1906.	Gross Weight. Ounces.
January..................	3,732·94
February..................	11,693·99
March..................	10·30
April..................	784·77
May..................	64,060·66
June..................	57,578·27
July..................	49,012·36
August..................	54,947·07
September..................	53,487·08
October..................	51,799·53
November..................	131·81
December..................	3,352·83
Total	350,591·61

(1) Report of the Director of the U.S. Mint for 1905, pages 44 and 45.

The crude gold is for the purpose of collecting the royalty valued at $15 per ounce, which would place the value of the production at $5,258,874. The grade (1) of gold found on the different creeks and along different positions of the same creek varies greatly. The lowest grade of gold found in the camp has a value of about $12.50 per ounce, while assays of $17.75 have been reported. It is exceedingly difficult to strike an average, but it is generally conceded that the average would exceed $15 per ounce. At $16 per ounce the value of the production in 1906 of 350,591·61 ounces would be $5,609,465. At $16.50 per ounce. which value experience has shown to be the average of Klondike gold received at United States mints and assay offices, the total value of the production would be $5,784,761.

Owing to the fact thus evidenced that it is difficult to obtain exact information regarding the value of the output, the figures of production in the accompanying table are given in round numbers. The statistics, however, in the main, are primarily based on the receipts of gold from the Canadian Yukon in the receiving offices of the United States Mint.

TABLE 10.

PRECIOUS METALS.

GOLD.—YUKON DISTRICT:—ANNUAL PRODUCTION.

Calendar Year.	Ounces Fine.	Value.	Calendar Year.	Ounces Fine.	Value.
		$			$
1885 } 1886 }	4,838	100,000	1897	120,948	2,500,000
			1898	483,793	10,000,000
1887	3,387	70,000	1899	774,069	16,000,000
1888	1,935	40,000	1900	1,077,640	22,275,000
1889	8,466	175,000	1901	870,827	18,000,000
1890	8,466	175,000	1902	701,500	14,500,000
1891	1,935	40,000	1903	592,646	12,250,000
1892	4,233	87,500	1904	507,983	10,500,000
1893	8,515	176,000	1905	381,035	7,876,000
1894	6,047	125,000	1906	270,924	5,600,000
1895	12,095	850,000			
1896	14,514	300,000	Total 1885 to 1906	....	121,039,500

The following statement of gold production of the Yukon, royalty paid, etc., is taken from the report of the Mines Branch of the Department of the Interior.

(1) Report of the gold values in the Klondike High Level Gravels—R. G. McConnell, Geological Survey, p. 12.

Fiscal Year.	Total Gold Production.	Total Exemption.	Royalty Collected on.	Royalty Paid.
	$	$	$	$
1898	3,072,773	339,845	2,732,928	273,292
1899	7,582,283	1,699,657	5,882,626	588,262
1900	9,809,464	2,501,744	7,307,720	730,771
1901	9,162,082	1,927,666	7,236,522	592,660
1902	9,566,340	1,199,114	8,367,225	331,436
1903	12,113,015	....	12,113,015	302,893
1904	10,790,663	....	10,790,663	272,217
1905	8,222,054	....	8,222,054	206,760
1906	6,540,007	....	6,540,007	163,963

British Columbia:—The value of the output of gold in British Columbia in 1906 was $5,579,039, as compared with $5,902,402 in 1905, a decrease of $323,363 or 5·47 per cent. Of the output in 1906 $948,400 was derived from placer workings, dredging, hydraulicing, etc., and $4,630,639 from lode mines.

The Provincial Mineralogist in his report to the Minister of Mines for the Province gives the special features of the gold production during the year as follows :—

" Placer Gold—The production of placer gold during the year 1906 was about $948,400, which is about 2·2 per cent less than that of 1905. This falling off, though slight, is general, and represents the lessened work of the individual miner, whose successors, the large companies, have not as get got into satisfactory operation.

The Atlin district produced very nearly as much gold as it did the previous year, chiefly the work of comparatively small companies, although in this district individual miners are still at work ; but the ground suited for this class of mining is gradually diminishing.

The two large dredges installed in this district have been practically abandoned, as the ground upon which they were working was found unsuitable for dredging operations.

A large steam shovel plant has been installed on shallow ground, and from present indications promises to be a large producer. The small shovel, the first installed in the district, has not been a commercial success, owing to the quite inadequate arrangements for handling and washing the dirt lifted.

In the Dease Lake section of Cassiar, despite the difficulties of transportation, one hydraulic company recovered between $20,000 and $25,000 in gold, and a second company will probably be in operation in 1907. Here, however, the individual miner has almost disappeared.

In the Cariboo district, the Cariboo mining division shows a marked increase over the preceding year, about 18·9 per cent, chiefly from small hydraulic enterprises; but the Quesnel division shows a decrease of about 30 per cent, due to the fact that the largest producing company did little mining, being taken up with large operations for increasing its water supply.

The Fort Steele district continues to produce a little gold from the old creeks, but the quantity is yearly diminishing.

The bars on the Thompson and Fraser rivers have been very disappointing, and the dredges installed thereon have not been successful.

Gold from Lode Mining—The value of the gold produced from lode mining in the Province in 1906 was $4,630,639, of which about 95 per cent was recovered from the smelting of copper-bearing ores. There are practically no stamps in operation since the Ymir mine ceased to operate, excepting one at Hedley."

TABLE 11.

PRECIOUS METALS.

GOLD.—BRITISH COLUMBIA :—ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1858	$ 705,000	1883	$ 794,252
1859	1,615,072	1884	736,165
1860	2,228,543	1885	713,738
1861	2,666,118	1886	903,651
1862	2,656,903	1887	693,709
1863	3,913,563	1888	616,731
1864	3,735,850	1889	588,923
1865	3,491,205	1890	494,436
1866	2,662,106	1891	429,811
1867	2,480,868	1892	399,525
1868	2,372,972	1893	379,535
1869	1,774,978	1894	530,530
1870	1,336,956	1895	1,266,954
1871	1,799,440	1896	1,788,206
1872	1,610,972	1897	2,724,657
1873	1,305,749	1898	2,939,852
1874	1,844,618	1899	4,202,473
1875	2,474,904	1900	4,732,105
1876	1,786,648	1901	5,318,703
1877	1,608,182	1902	5,961,409
1878	1,275,204	1903	5,873,036
1879	1,290,058	1904	5,704,908
1880	1,013,827	1905	5,902,402
1881	1,046,737	1906	5,579,039
1882	954,085		

TABLE 12.

PRECIOUS METALS.

GOLD.—BRITISH COLUMBIA :—PRODUCTION BY DISTRICTS—1906.

Districts.	Gold, Placer.		Gold, Lode.	
	Ounces.	Value.	Ounces.	Value.
		$		$
Cariboo—				
Cariboo division	17,790	355,800		
Quesnel "	1,980	39,600		
Omineca "	500	10,000		
Cassiar—				
Atlin Lake division	22,750	455,000		
All other divisions	2,200	44,000	2	41
East Kootenay—				
Fort Steele division	520	10,400		
Other divisions	....	....	10	207
West Kootenay—				
Ainsworth division	....	....	19	393
Nelson "	50	1,000	11,677	241,364
Slocan and Slocan City	....	....	69	1,426
Trail Creek	....	....	105,356	2,177,709
All other divisions	200	4,000	2,048	42,332
Lillooet	840	16,800	170	3,514
Yale—				
Grand Forks, etc	165	3,300	94,125	1,945,564
Similkameen, etc	125	2,500	6	124
Yale, etc	250	5,000	215	4,444
Coast and other divisions	50	1,000	10,330	213,521
Totals	47,420	948,400	224,027	4,630,639

The following tables show the production of the Rossland mines, and illustrate the average results attained during the past thirteen years.

NET PRODUCTION PER SMELTER RETURNS.

Year.	Ore, tons, 2,000 lb.	Gold, ozs.	Silver, ozs.	Copper, lb.	Value.
1894	1,856	3,723	5,357	106,229	$ 75,510
1895	19,693	31,497	46,702	840,420	702,459
1896	38,075	55,275	89,285	1,580,635	1,243,360
1897	68,804	97,024	110,068	1,819,586	2,097,280
1898	111,282	87,343	170,804	5,232,011	2,470,811
1899	172,665	102,976	185,818	5,693,889	3,229,086
1900	217,636	111,625	167,378	2,071,865	2,739,300
1901	283,360	132,333	970,460	8,333,446	4,621,299
1902	329,534	162,146	373,101	11,667,807	4,893,395
1903	360,786	145,353	209,537	8,652,127	4,255,958
1904	312,991	133,095	181,830	7,119,876	3,760,866
1905	330,618	129,843	147,753	5,800,294	3,672,828
1906	279,527	105,356	126,174	4,750,110	3,173,587

AVERAGE NET SMELTER RETURNS, OR ACTUAL YIELD PER TON.

Year.	Gold.	Silver.	Copper.	Value.
	Ounces.	Ounces.	Per cent.	$ cts.
1894	2·00	2·89	2·85	40.69
1895	1·60	2·41	2·10	35.67
1896	1·45	2·34	2·08	32.65
1897	1 42	1·60	1·32	30.48
1898	·78	1·54	2·35	22.10
1899	·596	1·07	1·65	18.70
1900	·513	·769	·476	12.58
1901	·467	3·424	1·470	16.31
1902	·492	1·132	1·770	14.85
1903	·403	·581	1·199	11.80
1904	·425	·581	1·137	12.01
1905	.393	.447	.877	11.11
1906	.377	.451	.850	11.35

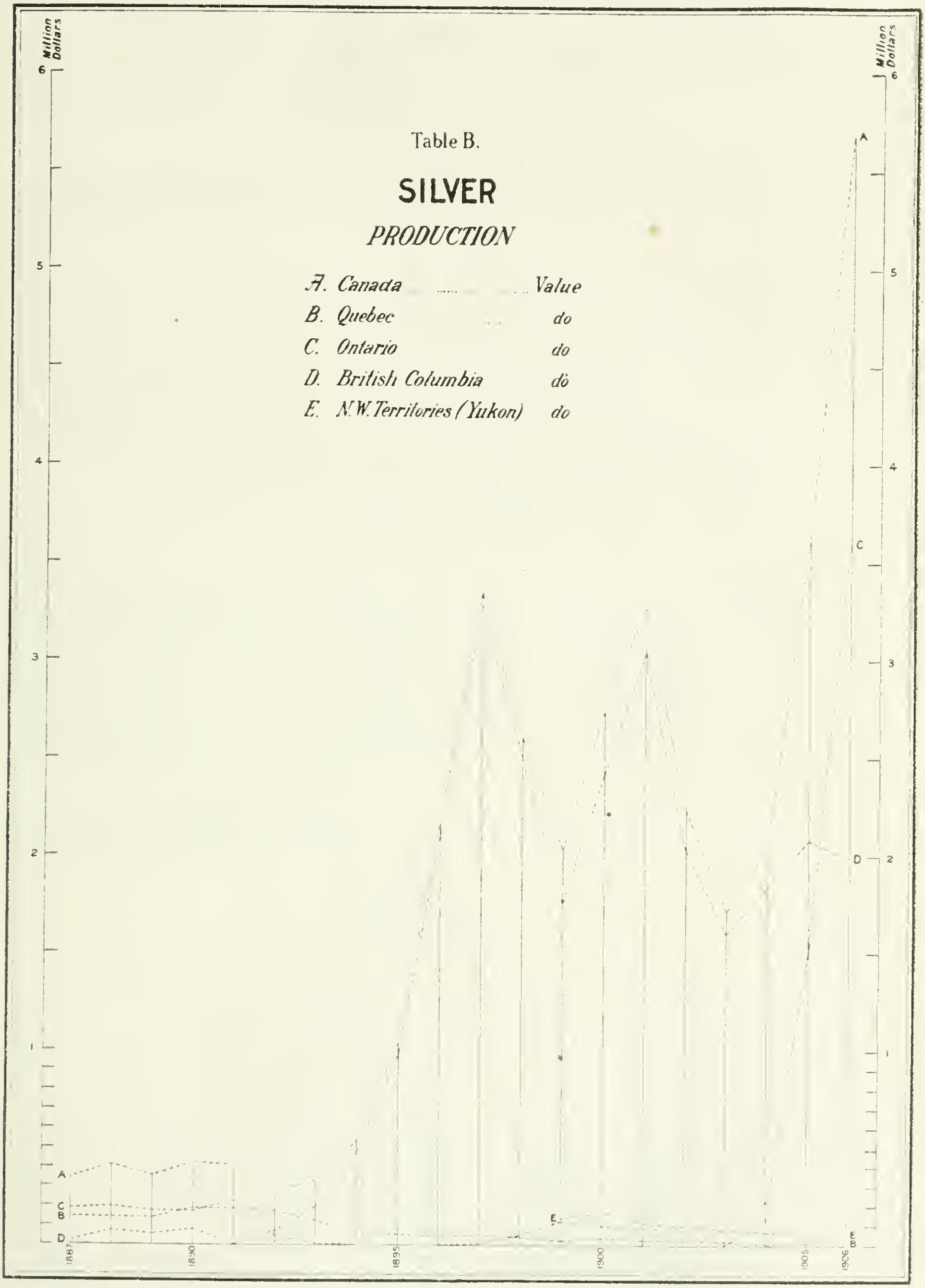
SILVER.

The production and shipment of the remarkably rich silver ores from the Cobalt district has resulted in a large increase in Canada's silver production. The total shipments in 1906 were about 8,473,379 ounces, contained in ore, matte, or other form, which, valued at 66·791 cents per ounce, the average, price of silver for the year in the New York market, represented a total ultimate value of $5,659,455. Compared with 1905 this is an increase in quantity of 2,483,712 ounces or 41·466 per cent. The average price of silver during the year was greater than in 1905, by 6·439 cents or 10·6 per cent.

The price of silver varied considerably during the year, the lowest average monthly price according to quotations published by the Engineering and Mining Journal, of New York, being 64·597 cents per ounce in March, and the highest 70·813 cents in November. The average monthly prices were as follows:—

AVERAGE MONTHLY PRICE OF SILVER DURING 1906.

Month.	Price.	Month.	Price.
	Cents.		Cents.
January	65·288	July	65·105
February	66·108	August	65·949
March	64·597	September	67·927
April	64·765	October	69·523
May	66·976	November	70·813
June	65·394	December	69·050
Average for the Year			66·791



Million Dollars
Table B.
SILVER
PRODUCTION
A. Canada Value
B. Quebec do
C. Ontario do
D. British Columbia do
E. N.W. Territories (Yukon) do
1887
1890
1895
1900
1905
1906

Of the total production in 1906 about 63·7 per cent was derived from the Cobalt district of Ontario; 33·5 per cent from the various silver ores of British Columbia; the balance representing the silver contained in the pyrites ores of Quebec, and the silver carried by the placer gold obtained from the Yukon.

Quebec:—The output from the Province of Quebec, as usual, is represented by the small amount contained in the pyrites ore mined in the vicinity of Capelton in the Eastern townships.

Ontario:—Although spasmodic attempts have been made in recent years to work the silver ores of the Silver Mountain district near Port Arthur, the main silver production of this Province is now obtained from the Cobalt District ores. From a beginning in 1904 of shipments aggregating somewhat over 150 tons, carrying 206,875 ounces of silver the production had increased in 1906 to shipments of 5,335 tons carrying 5,401,766 ounces of silver, and in addition the ores carry important values in cobalt and arsenic, although the mine owners have received payment for but a small proportion of the latter.

Ontario thus once more takes first place as a silver producer, formerly held at the time of the operation of the Silver Islet mines on Lake Superior. Since 1894, the argentiferous lead ores of British Columbia have been responsible for the greater part of the silver output in Canada, contributing over ninety per cent of the total until 1904. In 1905, however, British Columbia's proportion was reduced to 57 per cent, and Ontario's increased to 41 per cent.

Statistics of the production of silver are shown in table 13, while the details by provinces are given in table 14.

TABLE 13.

PRECIOUS METALS.

SILVER.—ANNUAL PRODUCTION.

Year.	Ounces.	Value.	Average price per ounce.	Year.	Ounces.	Value.	Average price per ounce.
		$	cts.			$	cts.
1887....	355,083	347,271	98·0	1897....	5,558,446	3,323,395	59·79
1888....	437,232	410,998	94 0	1898....	4,452,333	2,593,929	58·26
1889....	383,318	358,785	93·6	1899....	3,411,644	2,032,658	59·58
1890....	400,687	419,118	104·6	1900....	4,468,225	2,740,362	61·33
1891....	414,523	409,549	98·0	1901....	5,539,192	3,265,354	58·95
1892....	310,651	272,130	86·0	1902....	4,291,317	2,238,351	52·16
1893....	....	330,128	77·0	1903....	3,198,581	1,709,642	53·45
1894....	847,697	534,049	63·0	1904....	3,577,526	2,047,095	57·22
1895....	1,578,275	1,030,299	65·28	1905....	5,989,667	3,614,883	60·35
1896....	3,205,343	2,149,503	67·06	1906....	8,473,379	5,659,455	66·79

TABLE 14.

PRECIOUS METALS.

SILVER.—PRODUCTION BY PROVINCES.

Calendar Year.	Ontario.		Quebec.		British Columbia.		Yukon Territory.	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
		$		$		$		$
1887..	190,495	186,304	146,898	143,666	17,690	17,301	....	....
1888..	208,064	195,580	149,388	140,425	79,780	74,993	....	....
1889..	181,609	169,986	148,517	139,012	53,192	49,787	....	....
1890..	158,715	166,016	171,545	179,436	70,427	73,666	....	....
1891..	225,633	222,926	185,584	183,357	3,306	3,266	....	....
1892..	41,581	36,425	191,910	168,113	77,160	67,592	....	....
1893..	....	8,689	....	126,439	....	195,000	....	....
1894..	....	....	101,318	63,830	746,379	470,219	....	....
1895..	....	....	81,753	53,369	1,496,522	976,930	....	....
1896..	....	....	70,000	46,942	3,135,343	2,102,561	....	....
1897..	5,000	2,990	80,475	48,116	5,472,971	3,272,289	....	....
1898..	85,000	49,521	74,932	43,655	4,292,401	2,500,753	....	....
1899..	202,000	120,352	40,231	23,970	2,939,413	1,751,302	230,000	137,034
1900..	161,650	99,140	58,400	35,817	3,958,175	2,427,548	290,000	177,857
1901..	151,400	89,250	41,459	24,440	5,151,333	3,036,711	195,000	114,953
1902..	145,000	75,632	42,500	22,168	3,917,917	2,043,586	185,900	96,965
1903..	17,777	9,502	28,600	15,287	2,996,204	1,601,471	156,000	83,382
1904..	206,875	118,376	15,000	8,583	3,222,481	1,843,935	133,170	76,201
1905..	2,441,000	1,473,192	19,620	11,841	3,439,417	2,075,757	89,630	54,093
1906..	5,401,766	3,607,894	17,686	11,813	2,990,262	1,997,226	63,665	42,522

British Columbia :—The production by districts in British Columbia is shown in the following table :—

TABLE 15.

PRECIOUS METALS.

SILVER.—BRITISH COLUMBIA :—PRODUCTION BY DISTRICTS.

District.	1903.	1904.	1905.	1906.
	Ounces.	Ounces.	Ounces.	Ounces.
Cassiar....	53	185	477	26
Kootenay East—				
Fort Steele division........	28,537	590,186	1,137,872	1,049,536
Other divisions....	59,006	20,964	16,880	22,174
Kootenay West—				
Ainsworth division	108,678	90,004	99,781	165,915
Nelson "	190,003	198,795	116,729	211,122
Slocan "	1,466,931	1,540,170	1,045,948	571,613
Trail Creek "	209,537	181,830	147,753	126,174
Other divisions.......	392,354	148,201	121,551	79,262
Lillooet......	12	....	....	....
Yale—				
Osoyoos division...........	320,749	245,155	630,407	671,661
Yale	15	625	3,863	1,034
Coast and other districts.. ...	220,329	206,366	118,156	91,745
Totals..............	2,996,204	3,222,481	3,439,417	2,990,262

Compared with 1905 a decrease of 449,155 ounces or 13 per cent is shown. About 77 per cent of the silver is found in association with lead in argentiferous galena, the remainder being found in conjunction with copper ores.

Yukon :—The figures of silver production in the Yukon given in table 14 represent the silver found alloyed with the placer gold obtained from that district, there having been as yet no record of production of silver ores from the Windy Arm deposits.

EXPORTS :—The following table shows the value of the silver in ore matte or other form exported from Canada since 1886.

TABLE 16.

PRECIOUS METALS.

SILVER.—EXPORTS OF ORE.

Calendar Year.	Value.	Calendar Year.	Value.
1886	$ 25,957	1897	$ 3,576,391
1887	206,284	1898	2,902,277
1888	219,008	1899	1,623,905
1889	212,163	1900	2,341,872
1890	204,142	1901	2,026,727
1891	225,312	1902	1,820,058
1892	56,688	1903	1,989,474
1893	213,695	1904	1,904,394
1894	359,731	1905	2,777,218
1895	994,354	1906	5,686,444
1896	2,271,959		

COPPER.

The total production of copper in Canada in 1906 was 55,609,888 pounds, or by provinces as follows :—

Quebec	1,981,169	pounds.
Ontario	10,638,231	"
British Columbia	42,990,488	"
Total	55,609,888	"

This output shows a substantial increase of 15·6 per cent over the production in 1905, the increase being general throughout most of the copper producing districts.

Many of the ores from which copper is obtained in Canada contain considerable values in other constituents, in fact in many cases the copper may be considered as of secondary importance.

In Quebec the copper is derived from the pyrite deposits near Sherbrooke, which are primarily mined for the manufacture of sulphuric acid ; but which contain also, in addition to the copper,slight values in gold and silver. The production in Ontario is still practically represented by the copper contents of the nickel-copper ores of the Sudbury district, which contain also values in gold, silver, cobalt, and the platinum group of metals, although a small production is now obtained from a class of ores yielding copper only.

In British Columbia much the greater part of the output is now derived from the low grade sulphide ores of the Boundary district, the values of which in gold and silver would enable them to be worked at a profit, it is believed, even should the price of copper fall much below its present high level.

Prices :—The total value of the production in 1906, at the final average monthly price of the metal in New York according to the quotation published in the Engineering and Mining Journal, was $10,720,474, as compared with a total value in 1905 of $7,497,660, an increase of over 43 per cent. The average monthly price of the metal in 1906 was 19·278 cents per pound, compared with an average of 15·590 cents during the previous year, or an increase of over 23 per cent.

The average monthly prices of copper in New York were as follows :—

	Cents per lb.
January	18·310
February	17·869
March	18·361
April	18·375
May	18·475
June	18·442
July	18·190
August	18·380
September	19·033
October	21·203
November	21·833
December	22·885
Average for the year	19·278

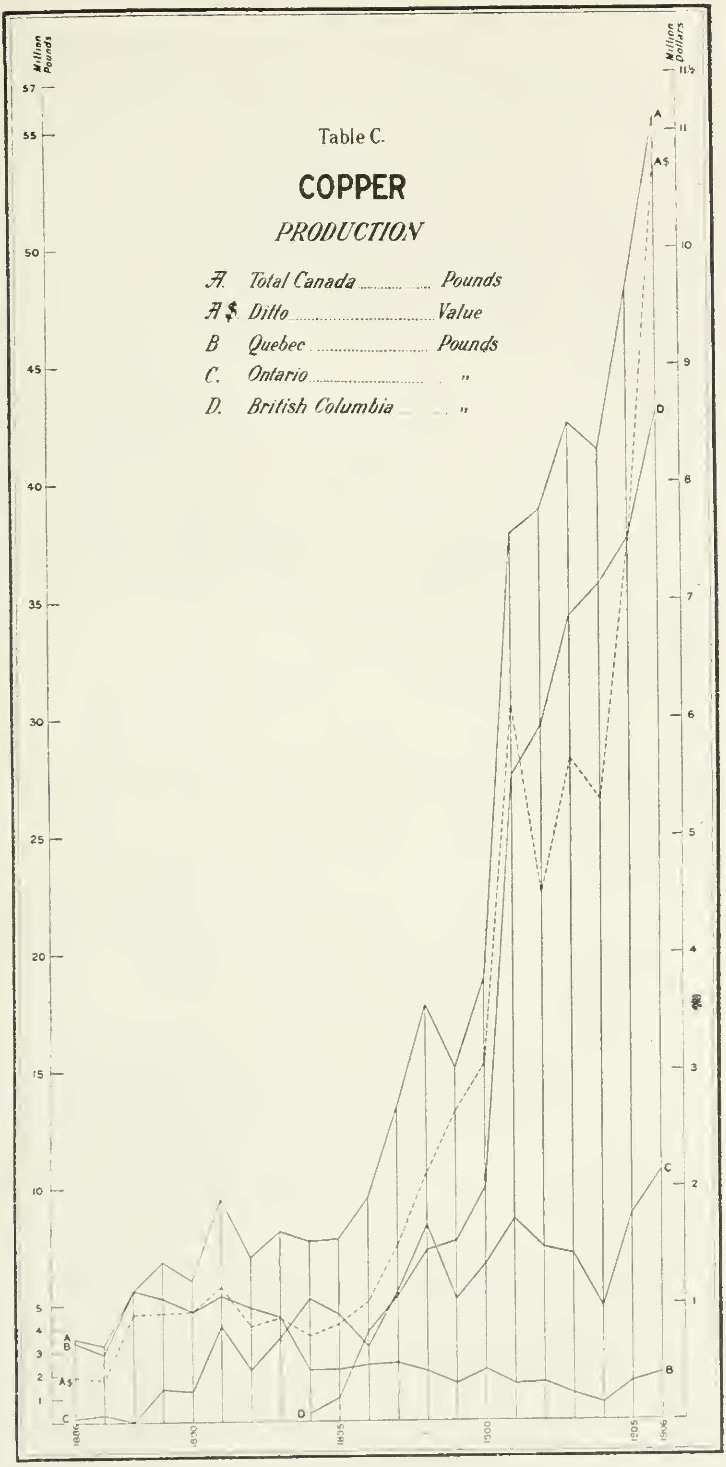


Table C.
COPPER
PRODUCTION
A. Total Canada .... Pounds
A $. Ditto .... Value
B Quebec .... Pounds
C. Ontario .... "
D. British Columbia .... "
Million Pounds
Million Dollars
1886
1890
1895
1900
1905
1906

Statistics of production, exports, and imports are given in the following tables :—

TABLE 1.

COPPER.

ANNUAL PRODUCTION.*

Calendar Year.	Lb.	Increase or Decrease.		Value.	Increase or Decrease.		Average Price per Pound.
		Lbs.	%		$	%	
				$			Cts.
1886.......	3,505,000	... .	....	385,550	....	....	11·00
1887......	3,260,424	244,576	6·99	366,798	18,752	4·86	11·25
1888.......	5,562,864	2,302,440	70·60	927,107	560,309	152·70	16·66
1889......	6,809,752	1,246,888	22·40	936,341	9,234	0·99	13·75
1890.......	6,013,671	796,081	11·69	947,153	10,812	1·15	15·75
1891.......	9,529,401	3,515,730	58·46	1,226,703	279,550	29·51	12·87
1892..	7,087,275	2,442,126	25·63	818,580	408,123	33·27	11·55
1893.......	8,109,856	1,022,381	14·40	871,809	53,229	6·50	10·75
1894.......	7,708,789	401,067	4·94	736,960	134,849	15·46	9·56
1895.......	7,771,639	62,850	·81	836,228	99,268	13·47	10·76
1896... ..	9,393,012	1,621,373	20·86	1,021,960	185,732	22·21	10·88
1897.....	13,300,802	3,907,790	41·60	1,501,660	479,700	46·94	11·29
1898.......	17,747,136	4,446,334	33·43	2,134,980	633,320	42·17	12·03
1899.......	15,078,475	2,668,661	15·04	2,655,319	520,339	24·37	17·61
1900. ...	18,937,138	3,858,663	25·59	3,065,922	410,603	15·46	16·19
1901......	37,827,019	18,889,881	99·75	6,096,581	3,030,659	98·84	16·117
1902.......	38,804,259	977,240	2·58	4,511,383	1,585,198	26·00	11·626
1903.	42,684,454	3,880,195	10·00	5,649,487	1,138,104	25·23	13·235
1904.......	41,383,722	1,300,732	3·05	5,306,635	342,852	6·07	12·823
1905......	48,092,753	6,709,031	16·21	7,497,660	2,191,025	41·29	15·590
1906. ...	55,609,888	7,517,135	15·63	10,720,474	3,222,814	42·98	19·278

* The production is altogether represented by the copper contained in ore, matte, etc., produced and shipped, valued at the average market price for the year for fine copper in New York.

NOTE.—In the above table, increases are shown underlined, and decreases in the ordinary way.

TABLE 2.

COPPER.

EXPORTS OF COPPER IN ORE, MATTE, ETC.

Calendar Year.	Pounds.	Value.
		$
1885		262,600
1886		249,259
1887		137,966
1888		257,260
1889		168,457
1890		398,497
1891		348,104
1892		277,632
1893	4,792,201	269,160
1894	1,625,389	91,917
1895	3,742,352	236,965
1896	5,462,052	281,070
1897	14,022,610	850,336
1898	11,572,381	840,243
1899	11,371,766	1,199,908
1900	23,631,523	1,741,885
1901	32,488,872	3,404,908
1902	26,094,498	2,476,516
1903	38,364,676	3,873,827
1904	38,553,282	4,216,214
1905	40,740,861	5,443,873
1906	42,398,538	7,303,366

TABLE 3.

COPPER.

IMPORTS OF PIGS, OLD, SCRAP, ETC.

Fiscal Year.	Lbs.	Value.	Fiscal Year.	Lbs.	Value.
		$			$
1880	31,900	2,130	1893	168,300	16,331
1881	9,800	1,157	1894	101,200	7,397
1882	20,200	1,984	1895	72,062	6,770
1883	124,500	20,273	1896	86,905	9,226
1884	40,200	3,180	1897	49,000	5,449
1885	28,600	2,016	1898	1,050,000	80,000
1886	82,000	6,969	1899	1,655,000	246,740
1887	40,100	2,507	1900	1,144,000	180,990
1888	32,300	2,322	1901	951,500	152,274
1889	32,300	3,288	1902	1,767,200	225,832
1890	112,200	11,521	1903	2,038,400	252,594
1891	107,800	10,452	1904	2,115,300	270,315
1892	343,600	14,894	1905	1,944,400	266,548

	Lbs.	Value.
1906 { Copper, old and scrap or in blocks..... Duty free.	445,200	63,765
1906 { Copper in pigs or ingots..... "	2,182,500	378,089
Total, 1906	2,627,700	441,854

TABLE 4.

COPPER.

IMPORTS OF MANUFACTURES.

Fiscal Year.	Value.
	$
1880	123,061
1881	159,163
1882	220,235
1883	247,141
1884	134,534
1885	181,469
1886	219,420
1887	325,365
1888	303,459
1889	402,216
1890	472,668
1891	563,522
1892	422,870
1893	458,715
1894	175,404
1895	251,615
1896	285,220
1897	264,587
1898	786,529
1899	551,586
1900	1,090,280
1901	951,045
1902	1,281,522
1903	1,291,635
1904	1,191,610
1905	1,775,881

		Duty.	Pounds.	$
1906	Copper in bolts, bars and rods, in coils, or otherwise in lengths not less than 6 feet, unmanufactured	Free.	11.227,600	1,922,071
	Copper, in strips, sheets or plates, not planished or coated, etc	"	2,547,200	519,808
	Copper tubing in lengths not less than 6 feet, and not polished, bent or otherwise manufactured	"	262,761	69,319
	Copper rollers, for use in calico printing, imported by calico printers for use in their own factories	"	....	6,697
	Copper and manufactures of :—			
	Nails, tacks, rivets and burrs or washers	30 p. c.	....	3,460
	Wire, plain, tinned or plated	15 "	216,517	40,095
	Wire cloth, etc	25 "	....	3,303
	All other manufactures of, N.O.P	30 "	....	95,550
	Total	....	....	2,660,303

Quebec:—As usual the copper production in Quebec was derived chiefly from pyrites ores of the Eastern townships, which are mined primarily for the manufacture of sulphuric acid.

Statistics showing the copper contained in the ore shipped are given in table 5 following :—

TABLE 5.

COPPER.

QUEBEC :—PRODUCTION.

Calendar Year.	Pounds.	Value.
		$
1886	3,340,000	367,400
1887	2,937,900	330,514
1888	5,562,864	927,107
1889	5,315,000	730,813
1890	4,710,606	741,920
1891	5,401,704	695,469
1892	4,883,480	564,042
1893	4,468,352	480,348
1894	2,176,430	208,067
1895	2,242,462	241,288
1896	2,407,200	261,903
1897	2,474,970	279,424
1898	2,100,235	252,658
1899	1,632,560	287,494
1900	2,220,000	359,418
1901	1,527,442	246,178
1902	1,640,000	190,666
1903	1,152,000	152,467
1904	760,000	97,455
1905	1,621,243	252,752
1906	1,981,169	381,930

Ontario :—While the greater part of the copper production of this Province is derived from the nickel-copper ores of the Sudbury district, there was considerable activity during the year in the development of copper properties; but, although some 18,000 tons of ore were mined from these, only a small quantity was shipped.

The total quantity of nickel-copper ore mined during the year was 343,814 tons; while 340,059 tons were smelted, producing 20,346 tons of Bessemer matte. The quantity of matte shipped during the year was 20,310 tons, containing 5,264 tons of copper and 10,745 tons of nickel, the value of the matte being about $4,628,011.

The companies producing these ores were :—

The Canadian Copper Co., Copper Cliff, Ont.

The Mond Nickel Co., Victoria Mines, Ont.

Amongst the other copper properties a 50 ton smelter was operated by the Medina Copper Company at Eldorado.

TABLE 6.

COPPER.

ONTARIO :—PRODUCTION.

Calendar Year.	Pounds.	Value.
		$
1886	165,000	18,150
1887	322,524	36,284
1888	Nil.	Nil.
1889	1,466,752	201,678
1890	1,303,065	205,233
1891	4,127,697	531,234
1892	2,203,795	254,538
1893	3,641,504	391,461
1894	5,207,679	497,854
1895	4,576,337	492,414
1896	3,167,256	344,598
1897	5,500,652	621,023
1898	8,375,223	1,007,539
1899	5,723,324	1,007,877
1900	6,740,058	1,091,215
1901	8,695,831	1,401,507
1902	7,408,202	861,278
1903	7,172,533	949,285
1904	4,913,594	630,070
1905	8,779,259	1,368,686
1906	10,638,231	2,050,838

British Columbia ;—The copper production in this Province continues to increase, it being now in point of value the most important mineral product in the Province. The production in 1906, 42,990,488 pounds, shows an increase of 5,298,237 pounds or 14 per cent over the production in 1905. At the final price of copper in New York the value of the production in 1906 was $8,287,706.

The mines of the Boundary district produced about 75 per cent of the total ; the mines of the Coast district about 12 per cent, and the Rossland mines 11 per cent.

TABLE 7.

COPPER.

BRITISH COLUMBIA—PRODUCTION.

Calendar Year.	Copper contained in ores, matte, etc.	Increase.		Value.
	Lbs.	Lbs.	%	
1894	324,680			$ 31,039
1895	952,840	628,160	193	102,526
1896	3,818,556	2,865,716	301	415,459
1897	5,325,180	1,506,624	39	601,213
1898	7,271,678	1,946,498	36	874,783
1899	7,722,591	450,913	6	1,359,948
1900	9,977,080	2,254,489	29	1,615,289
1901	27,603,746	17,626,666	177	4,448,896
1902	29,636,057	2,032,311	7	3,445,488
1903	34,359,921	4,723,864	16	4,547,735
1904	35,710,128	1,350,207	3·7	4,579,110
1905	37,692,251	1,982,123	5·6	5,876,222
1906	42,990,488	5,298,237	14·1	8,287,706

TABLE 8.

BRITISH COLUMBIA—PRODUCTION BY DISTRICTS.

—	1903.	1904.	1905.	1906.
	Pounds.	Pounds.	Pounds.	Pounds.
Cassiar	2,249	8,900		293,269
East Kootenay	2,730	5,472	10,606	6,910
West Kootenay—				
Nelson	346,218	220,500	92,663	216,034
Slocan	181			2,861
Trail Creek	8,652,127	7,119,876	5,800,294	4,750,110
All other	3,294			1,145
Yale—				
Boundary	18,485,542	22,066,407	27,670,644	32,226,782
Ashcroft, Kamloops	6,409	328,380	680,808	355,377
Coast districts	6,861,171	5,960,593	3,437,236	5,138,000
	34,359,921	35,710,128	37,692,251	42,990,488

Yukon District:—A considerable amount of exploratory work was done on copper properties at Whitehorse, Yukon district, during the year, and about 100 tons shipped from one of the claims. A short description of some of the mining claims in this district will be found in the Summary Report of the Geological Survey for 1906, pages 24 and 25.

IRON.

Iron Ore:—The total production (shipments) of iron ore in Canada in 1906 was 248,831 tons, valued at the mines at $522,242. By provinces the production was as follows:—

—	Short tons.	Value.
Nova Scotia	97,820	$151,386
Quebec	9,933	32,938
Ontario	141,078	337,918
Total	248,831	$522,242

The production in Nova Scotia includes nearly 50,000 tons of ankerite ore, carrying a low iron content, which is used as a flux; the balance was derived from the mines at Torbrook, Brookfield, and Londonderry. The total output was utilized by the Londonderry Iron and Mining Company at their blast furnace at Londonderry.

In Quebec the bog iron of Champlain, Joliette, Drummond, Nicolet, St. Maurice, and Vaudreuil counties, was as usual mined and used in the furnaces at Radnor Forges and Drummondville.

In Ontario about 5,000 tons of ore were shipped from the Radnor mine in Renfrew county, owned by the Canada Iron Furnace Co., and the Mineral Range Iron Co.'s mine in Hastings county, the balance of the shipments being from the Helen mine at Michipicoten, owned by the Lake Superior Power Co. The actual amount of ore mined was probably somewhat less than the above figures, as a portion of the shipments from the Helen mine was from stocked ore. The quantity of ore raised, according to the Ontario Bureau of Mines Report, was 128,049 tons. The shipments from the Radnor mine were made to the furnaces at Radnor Forges, Quebec; while of the shipments from Michipicoten about 55 per cent went to Sault Ste Marie and Hamilton, Ont., and the balance to Buffalo, Cleveland and Detroit.

TABLE 1.

IRON.

PRODUCTION OF ORE BY PROVINCES.

Calendar Year.	Nova Scotia.	Quebec.	Ontario.	British Columbia.	Total.
	Tons.	Tons.	Tons.	Tons.	Tons.
1886	44,388	....	16,032	3,941	64,361
1887	43,532	13,401	16,598	2,796	76,330
1888	42,611	10,710	16,894	8,372	78,587
1889	54,161	14,533	....	15,487	84,181
1890	49,206	22,305	....	....	76,511
1891	53,649	14,380	....	950	68,979
1892	78,258	22,690	....	2,300	103,248
1893	102,201	22,076	....	1,325	125,602
1894	89,379	19,492	....	1,120	109,991
1895	83,792	17,783	....	1,222	102,797
1896	58,810	17,630	15,270	196	91,906
1897	23,400	22,436	2,770	2,099	50,705
1898	19,079	17,873	21,111	280	58,343
1899	28,000	19,420	25,126	2,071	74,617
1900	18,940	19,000	82,950	1,110	122,000
1901	18,619	15,489	272,538	7,000	313,646
1902	16,172	18,524	359,288	10,019	404,003
1903	40,335	12,035	209,634	2,290	264,294
1904	61,293	16,152	141,601	....	219,046
1905	84,952	12,681	193,464	....	291,097
1906	97,820	9,933	141,078	....	248,831

TABLE 2.

IRON.

NOVA SCOTIA:—ANNUAL PRODUCTION OF ORE.
(Previous to 1886).

Calendar Year.	Tons.	Calendar Year.	Tons.
1876	15,274	1881	39,843
1877	16,879	1882	42,135
1878	36,600	1883	52,410
1879	29,889	1884	54,885
1880	51,193	1885	48,129

The exports of iron ore from Canada, as compiled from Customs reports, are shown in tables 3 and 4 for the calendar and fiscal years respectively. Nearly all the iron ore exported goes to the United States. Table 4a, which has therefore been added to show the quantity of iron ores imported into the United States from Canada, has been compiled from "The Foreign Commerce and Navigation of the United States" published at Washington.

A comparison of tables 4 and 4a, shows large discrepancies for the years 1901 to 1905, inclusive. The Canadian figures of exports for

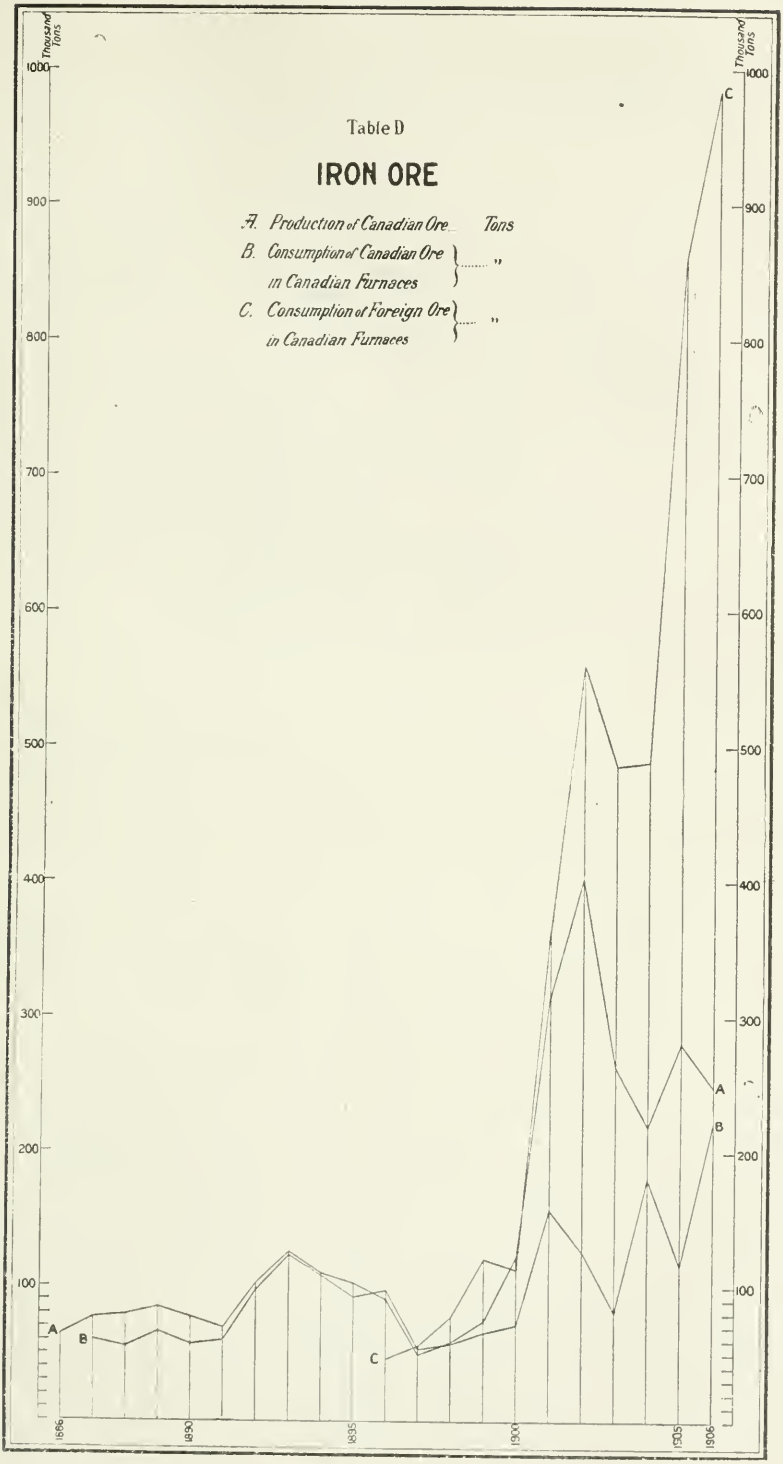


Table D
IRON ORE
A. Production of Canadian Ore ... Tons
B. Consumption of Canadian Ore in Canadian Furnaces ... "
C. Consumption of Foreign Ore in Canadian Furnaces ... "
Thousand Tons
1000
900
800
700
600
500
400
300
200
100
1886
1890
1895
1900
1905
1906
A
B
C

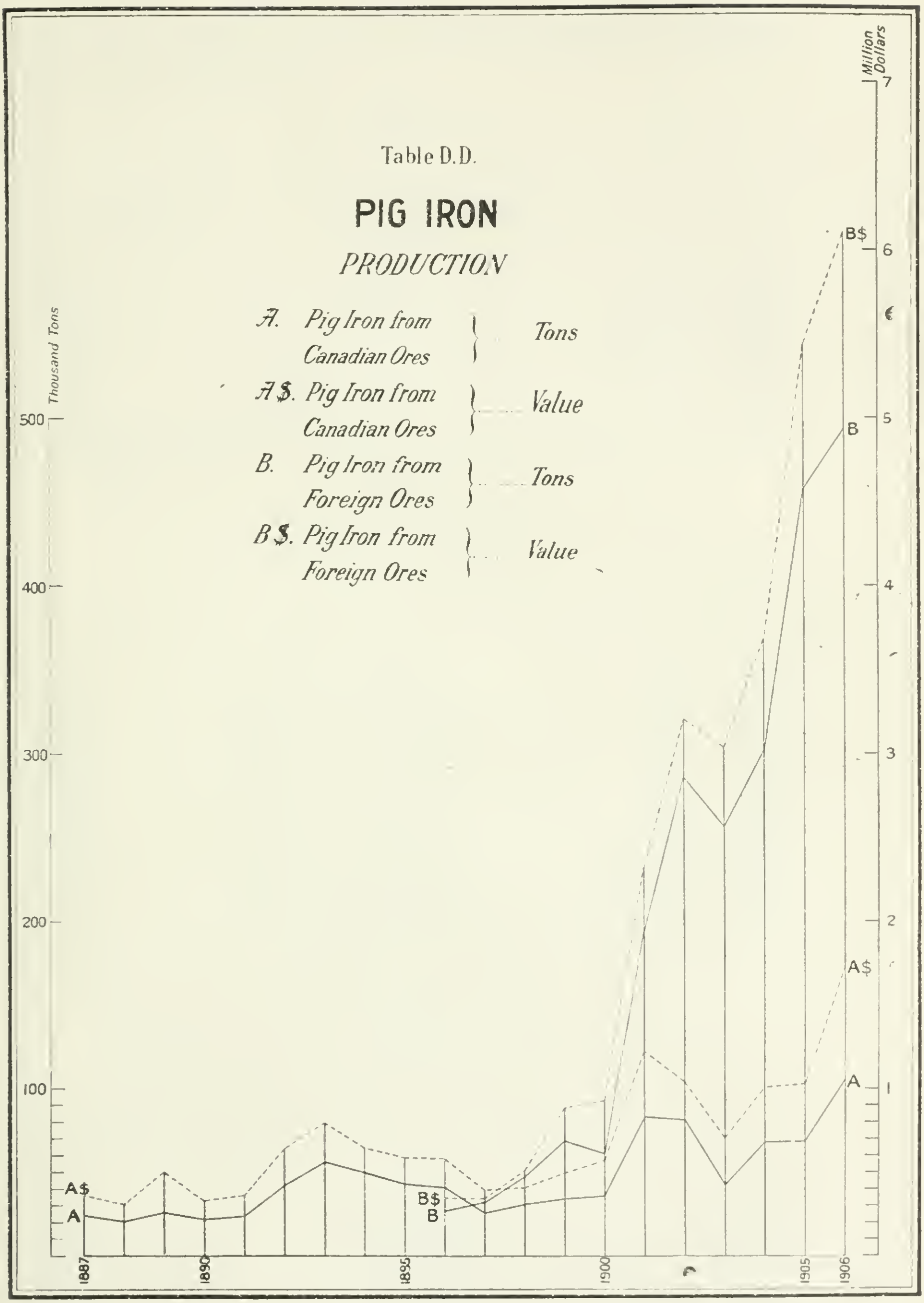


Table D.D.
PIG IRON
PRODUCTION
A. Pig Iron from Canadian Ores — Tons
A$. Pig Iron from Canadian Ores — Value
B. Pig Iron from Foreign Ores — Tons
B$. Pig Iron from Foreign Ores — Value
Thousand Tons
Million Dollars
500
400
300
200
100
7
6
5
4
3
2
1
A$
A
B$
B
1887
1890
1895
1900
1905
1906

these years are evidently much two high, and an investigation has shown that an error had crept into the Customs returns, owing to a duplication of certain entries.

TABLE 3.

IRON.

EXPORTS OF IRON ORE.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
		$			$
1893	2,419	7,590	1900	5,527	13,511
1894	....	21,294	1901*	306,199	762,283
1895	1,571	3,909	1902*	428,901	1,065,019
1896	1,033	1,911	1903*	368,233	922,571
1897	403	811	1904*	168,828	401,738
1898	182	278	1905*	168,289	407,881
1899	4,145	9,538	1906	74,778	149,177

* The export figures for the four years indicated are incorrect owing to a duplication of entries.

TABLE 4.

IRON.

EXPORTS OF IRON ORE.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
		$			$
1879	3,562	7,530	1893	7,811	26,114
1880	30,524	76,474	1894	1,859	9,026
1881	44,677	114,850	1895	2,315	5,743
1882	43,835	135,463	1896	14	35
1883	44,914	138,775	1897	1,320	2,492
1884	25,308	66,549	1898	260	402
1885	54,367	132,074	1899	1,849	4,968
1886	7,542	23,039	1900	4,327	7,689
1887	23,345	71,934	1901*	58,401	150,657
1888	13,544	39,945	1902*	525,983	1,303,901
1889	24,752	60,289	1903*	293,510	733,230
1890	13,811	31,376	1904*	233,850	579,883
1891	14,648	32,582	1905*	224,908	540,909
1892	7,707	36,935	1906*	148,040	345,540

* See footnote to table 3, also table 4a, and remarks.

TABLE 4a.

IRON.

IMPORTS OF IRON ORE INTO THE UNITED STATES FROM CANADA.*

Year ending June 30.	Tons.	Year ending June 30.	Tons.
1893	6,880	1900	3,997
1894	269	1901	30,762
1895	2,394	1902	276,363
1896	35	1903	129,219
1897	2,263	1904	113,388
1898	1,172	1905	107,358
1899	2,308	1906	101,615

* Compiled from the "Foreign Commerce and Navigation of the United States."

Pig Iron:—The total production of pig iron in blast furnaces in Canada in 1906 was 598,411 short tons, valued at $7,955,136 at the furnace, as compared with 525,306 tons, valued at $6,475,186, in 1905. The production is over twice that made in 1903. Statistics of the production of pig iron, together with the iron ore, fuel and flux used, are given in table 5 for the years 1887 to 1906 inclusive. Previous to 1896 the pig iron manufactures were entirely from Canadian ore. Since that date, however, increasing quantities of imported ore have been used, which will be found separately stated in the table. Of the total production in 1906, 18,906 tons were made with charcoal and 579,509 tons with coke.

The production by provinces was as follows:—

—	Tons.	Value.
Nova Scotia	315,008	$ 3,439,217
Quebec	7,845	177,644
Ontario	275,558	4,338,275
Total	598,411	$ 7,955,136

The greater part of the ore charged to the Canadian furnaces continues to be imported. A large amount of the coke used, as well as a considerable portion of the limestone flux employed, is also imported. This metallurgical industry is, therefore, to a large extent dependent on imported raw material, a condition which is due to the commercial necessity of securing the raw material at a minimum cost whether this be secured in the country or out of it.

In 1906 a total of 1,204,473 tons of ore was charged to Canadian blast furnaces, of which 982,740 tons or 81·5 per cent were imported, chiefly from Newfoundland and the south shore of Lake Superior. It should be kept in mind, however, that a certain amount of ore from Canadian mines, chiefly Michipicoten, is exported to the United States. The development of important ore bodies at Bessemer and Moose Mountain, Ont., will probably also in the near future reduce the proportion of imported ore used.

TABLE 5.

IRON.

PIG IRON PRODUCTION:—CONSUMPTION OF ORE, FUEL, etc.

Calendar Year.	Iron Ore Consumed.		Fuel Consumed.						Flux Consumed.		Pig Iron Made.		
			Charcoal.		Coke.		Coal.						
	Tons.	Value.	Bushels.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value per ton.
1887	60,434	$130,808	940,400	$48,593	30,248	$89,123	3,333	$5,877	17,171	$17,500	24,827	$366,192	$14.75
1888	54,956	102,343	804,286	41,800	28,031	82,986	2,197	4,709	16,857	16,533	21,799	313,235	14.37
1889	65,670	126,064	755,800	41,568	33,289	94,791	3,044	6,525	22,122	21,909	25,921	499,872	19.28
1890	57,304	117,880	589,860	29,493	32,832	97,659	1,241	2,638	18,478	18,361	21,772	331,688	15.23
1891	60,935	130,955	441,812	22,091	30,626	98,402	2,170	2,868	11,377	11,546	23,891	368,901	15.44
1892	96,948	250,966	1,121,365	78,291	50,882	152,311	1,740	1,797	22,967	21,687	42,443	637,421	15.02
1893	124,053	296,979	1,302,720	90,976	58,711	163,849	6,621	13,539	27,797	27,519	55,947	790,283	14.13
1894	108,871	223,861	1,173,970	53,958	52,373	142,303	7,653	14,571	35,101	34,347	49,967	646,447	12.94
1895	93,208	218,336	789,561	31,582	48,540	139,475	3,089	5,396	31,585	29,922	42,454	586,736	13.82
1896	(a) 96,560 (b) 46,300	200,887 100,205	756,600	32,256	(a) 48,660 (b) 33,990	106,939 109,253	1,407	2,288	37,462	36,140	67,268	924,129	13.74
1897	(a) 53,658 (b) 55,722	131,705 138,504	1,031,800	43,230	(a) 35,800 (b) 27,810	71,600 94,553	......	....	31,273	30,258	58,007	738,701	12.73
1898	(a) 57,881 (b) 77,107	151,760 213,165	836,400	41,820	(a) 31,952 (b) 50,407	63,904 158,783	......	....	33,913	31,153	77,015	912,395	11.85
1899	(a) 66,384 (b)120,650	216,322 402,860	1,928,025	87,858	(a) 44,841 (b) 64,648	134,532 193,944	......	....	51,826	44,286	102,943	1,377,306	13.38
1900	(a) 71,341 (b)113,042	184,191 351,382	1,799,737	82,108	(a) 45,021 (b) 59,345	180,084 255,892	......	....	52,966	39,332	96,575	1,501,698	15.55
1901	(a)156,613 (b)361,010	544,144 846,398	1,835,736	100,978	(a) 205,796 (b) 115,367	539,328 497,386	2,039	6,117	169,399	183,162	274,376	3,512,923	12.80
1902	(a)125,664 (b)559,381	429,753 964,979	2,146,623	118,275	(a) 360,593 (b) 112,314	898,518 494,433	1,615	5,006	293,594	219,295	357,902	4,243,541	11.85
1903	(a) 82,035 (b)485,911	247,229 823,147	2,322,030	152,717	(a) 350,190 (b) 96,540	819,016 556,091	......	....	277,452	249,251	297,885	3,742,710	12.56
1904	(a)180,932 (b)454,671	489,687 922,594	3,477,470	191,101	(a)257,182 (b)130,210	729,585 551,445	......	....	211,278	177,595	303,454	3,687,985	12.15
1905	(a)116,974 (b)861,847	351,965 1,802,539	4,104,394	222,156	(a)365,897 (b)243,882	962,518 1,233,515	......	.....	369,715	282,711	525,306	6,475,186	12.33
1906	(a)221,733 (b)982,740	683,238 1,984,720	2,168,476	125,992	(a)462,672 (b)304,676	1,248,797 1,607,324	..	....	456,036	356,733	598,411	7,955,136	13.29

(a) Canadian. (b) Imported.

In the tabulated statement showing the mineral production of Canada, the production from Canadian ore only is given. This has been arrived at by separating the total production at each furnace into two classes, viz., pig iron from Canadian ore and pig iron from imported ore, the separation being made on the basis of the Canadian and imported ore entering into the production of pig iron at each respective furnace.

The production for the past eleven years separated in this way has been as follows :—

Calendar Year.	Pig iron from Canadian ore.	Pig iron from Imported ore.
	Tons.	Tons.
1896	40,720	26,548
1897	26,200	31,807
1898	30,553	46,462
1899	34,244	68,699
1900	35,387	61,188
1901	83,100	191,276
1902	71,664	286,238
1903	42,052	255,833
1904	68,297	235,157
1905	68,170	457,136
1906	104,660	493,751

During the year there were thirteen furnaces in blast for varying periods, operated by the following companies :—

Dominion Iron and Steel Co, Sydney, C.B., four completed furnaces of 275 tons capacity each per day, all of which were operated during the year.

Nova Scotia Steel and Coal Co., New Glasgow, N.S., one furnace at Sydney Mines, C.B., of 200 tons capacity.

Londonderry Iron and Mining Co., Limited, Londonderry, N.S., one furnace of 100 tons capacity.

John McDougall & Co., Montreal, Que., two small furnaces at Drummondville, Que., one of which was operated the whole year.

Canada Iron Furnace Co., Ltd., Montreal, Que., one furnace of 150 tons at Midland, Ont.

Deseronto Iron Co , Ltd., Deseronto, Ont., one furnace with a daily capacity of about 35 tons.

Hamilton Steel and Iron Co., Hamilton, Ont., one furnace of 300 tons capacity operated throughout the year, and a second furnace of 300 tons in course of construction.

Algoma Steel Co., Ltd , Sault Ste Marie, Ont., two furnaces at Steelton near Sault Ste Marie, of a combined capacity of about 400 tons.

The Atikokan Iron Co., Ltd., was also building at Port Arthur Ont., a furnace with a capacity of about 100 tons per day.

Of the fourteen completed furnaces nine were in blast and five were idle, on Dec. 31, 1906. The total capacity of the fourteen furnaces, if in continuous operation, would be about 800,000 tons per annum.

The number of men employed was 1,808, and about $1,000,000 was paid in wages.

Bounties :—Bounties on iron and steel, made in Canada, were provided for by the Dominion government in 1897 (chapter 6, Statutes of Canada, 1897.) This Act was amended in 1899 (chapter 8, Statutes of Canada, 1899), and again in 1903 (chapter 68, Statutes of Canada, 1903).

The Act of 1903 also provides for the gradual extinguishment of the bounties authorized in 1897 as follows :—

Period.	On steel ingots, puddled iron bars, and pig iron from Canadian ore.	On pig iron from foreign ore.
	Per ton.	Per ton.
From July 1, 1903 to June 30, 1904	$ 2 70	$ 1 80
" 1904 " " 1905	2 25	1 50
" 1905 " " 1906	1 65	1 10
" 1906 " " 1907	1 05	0 70

The payments by the Dominion Government on account of iron and steel bounties during the fiscal year ending June 30, 1906, were as follows, the figures having been compiled from the Auditor General's Report for 1906.

BOUNTIES PAID ON PIG IRON MANUFACTURED IN CANADA, FISCAL YEAR 1905-6.

Company.	On Pig Iron from Canadian Ore. Tons.	On Pig Iron from Canadian Ore. Bounties.	On Pig Iron from Imported Ore Tons.	On Pig Iron from Imported Ore Bounties.	Total Bounties.
		$ cts.		$ cts.	$ cts.
Algoma Steel Co., Ltd....	4,640·01	7,656 15	145,239·82	159,763 81	167,419 96
Canada Iron Furnace Co. Ltd.—					
Midland, Ont.	31,09·00	51 31	29,055·90	31,961 47	32,012 78
Radnor Forges, Que....	3,615·48	5,965 54	2,070·35	2,277 39	8,242 93
Deseronto Iron Co., ...	674·00	1,122 10	11,411·00	12,552 10	13,664 20
Dominion Iron and Steel Co.	5·64	9 30	223,948·94	246,343 83	246,353 13
Hamilton Steel and Iron Co., Ltd..........	43,634·58	71,997 03	24,449·79	26,894 75	98,891 78
John McDougall & Co....	2,695·19	4,447 06	....	....	4,447 06
Londonderry Iron & Mining Co., Ltd	31,227·38	51,525 16	....	....	51,525 16
Nova Scotia Steel and Coal Co., Ltd	....	.. ....	59,158·90	65,074 79	65,074 79
	86,523·468	142,763 65	495,334 70	544,868 14	687,631 79

BOUNTY ON STEEL INGOTS AND PUDDLED IRON BARS, FISCAL YEARS 1905-6.

Company.	Tons.	Bounty.
		$ cts.
Algoma Steel Company, Steel Ingots	222,891·06	367,770 24
Dominion Iron and Steel Co., Ltd., Steel Ingots......	246,356·02	406,487 47
Steel Ingots made during the year 1903-4......... . ..	771·53	2,083 13
Hamilton Steel and Iron Co., Ltd., Steel Ingots..	41,124·60	67,855 55
Puddled Iron Bars......	3,560·42	5,874 71
Nova Scotia Steel and Coal Co., Ltd., Steel Ingots.....	56,915·64	93,910 79
	571,619·27	943,981 89

BOUNTIES PAID ON ARTICLES MANUFACTURED FROM STEEL, FISCAL YEAR 1905-6.

Company.	Tons.	Bounty.
		$ cts.
Dominion Iron and Steel Co., Ltd.—		
Steel Wire Rods at $6.....	50,184·45	301,106 73
" " Arrears of 1904-5 at $6............	217·775	1,306 65
Hamilton Steel and Iron Co., Ltd.—		
Steel Angles at $3.............................	11,405·73	34,217 19
Montreal Rolling Mills Co.—		
Rail Joints, Slates, etc., at $3.	2,462·19	7,386 56
Nova Scotia Steel and Coal Co.—		
Plates, Angles, etc. at $3........................	8,604·86	25,814 60
	72,875·005	369,831 73

Total Bounties paid to each Company, Fiscal Year ending June 30, 1906.

Algoma Steel Co., Ltd	$ 535,190 20
Canada Iron Furnace Co., Ltd	40,255 71
Deseronto Iron Co., Ltd	13,664 20
Dominion Iron and Steel Co., Ltd	957,337 11
Hamilton Steel and Iron Co., Ltd	206,839 23
John McDougall & Co	4,447 06
Londonderry Iron and Mining Co., Ltd	51,525 16
The Montreal Rolling Mills Co	7,386 56
Nova Scotia Steel and Coal Co., Ltd	187,692 79
	2,004,338 02

The total amount of bounties on iron and steel paid by the Dominion Government during the fiscal year ending June 30, 1906, was, therefore, as follows :—

Bounties on pig iron	$ 687,631 79
" steel ingots and puddled iron bars	943,981 89
" articles manufactured from steel	369,831 73
Arrears to Nova Scotia Steel and Coal Co., Ltd., from July 1903 to July 1905	2,892 61
	2,004,338 02

Since the first of January 1907, the rate of bounty payment on iron and steel has been changed by an Act assented to 27th April 1907, (Chapter 24, Statutes of Canada, 1907). The new Act governing bounty payments is as follows :—

An Act respecting Bounties on Iron and Steel made in Canada.

(Assented to 27th April, 1907).

His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows :—

1. The Governor in Council may authorize the payment out of the Consolidated Revenue Fund of the following bounties on the undermentioned articles when manufactured in Canada for consumption therein, viz. :—

(*a*) In respect of pig iron manufactured from ore, on the proportion from Canadian ore produced during the calendar year —

1907	$2 10 per ton.
1908	2 10 "
1909	1 70 "
1910	0 90 "

(*b*) In respect of pig iron manufactured from ore, on the proportion from foreign ore produced during the calendar year—

1907	$1 10 per ton.
1908	1 10 "
1909	0 70 "
1910	0 40 "

(*c*) On puddled bar iron manufactured from pig iron made in Canada during the year.

1907	$1 65 per ton.
1908	1 65 "
1909	1 05 "
1910	0 60 "

(*d*) In respect of rolled, round wire rods not over three-eighths of an inch diameter, manufactured in Canada from steel produced in Canada from ingredients of which not less than fifty per cent of the weight thereof consists of pig iron made in Canada, on such wire rods made after the thirty-first day of December, one thousand nine hundred and six, six dollars per ton.

(*e*) In respect of steel manufactured from ingredients of which not less than fifty per cent of the weight thereof consists of pig iron made in Canada, on such steel made during the calendar year—

1907	$1 65 per ton.
1908	1 65 "
1909	1 05 "
1910	0 60 "

2. No bounty shall be paid under the foregoing provisions in respect of iron or steel made in Canada by electric process after the thirty-first day of December, one thousand nine hundred and eight.

1. The Governor in Council may authorize the payment out of the Consolidated Revenue Fund of the following bounties on the undermentioned articles when manufactured in Canada for consumption therein, viz. :—

(*a*) On pig iron manufactured from Canadian ore by the process of electric smelting during the calendar year—

1909	$2 10 per ton.
1910	2 10 "
1911	1 70 "
1912	0 90 "

(*b*) On steel manufactured by electric process from pig iron smelted in Canada by electricity from Canadian ore during the calendar year—

1909	$1 65 per ton.
1910	1 65 "
1911	1 05 "
1912	0 60 "

2. Bounty, as on pig iron under this section, may be paid upon the molten iron from the ore which in the electric furnace enters into the manufacture of steel by the direct process, th weight of the steel so manufactured.

3. No bounty shall be paid on steel ingots from which steel blooms and billets for exportation from Canada are manufactured.

4. The Governor in Council may make regulations to carry out the intention of this Act.

5. The Minister of Trade and Commerce shall be charged with the administration of this Act.

6. Chapter 8 of the Statutes of 1899, Chapter 68 of the Statutes of 1903, and Chapter 39 of the Statutes of 1904, are repealed.

7. This Act shall be deemed to have come into force on the first day of January, one thousand nine hundred and seven.

Table 6 illustrates the extent of the foreign trade of the country in regard to iron and steel products and machinery, etc., made therefrom.

TABLE 6.

IRON.

EXPORTS OF IRON AND STEEL GOODS, THE PRODUCT OF CANADA.

Calendar Year 1905.		Quantity.	Value.
			$
Stoves	No.	974	10,295
Castings, N.E.S	$	....	48,903
Pig iron	Tons.	305	7,429
Machinery, N E.S	$	....	424,057
Sewing machines	No.	1,477	33,690
Typewriters	"	5,502	164,466
Scrap iron and steel	Cwt.	258,938	235,913
Hardware	$	....	164,649
Steel and manufactures of	"	....	463,561
Total		....	1,552,963

The Canadian consumption of iron and steel products is illustrated in the following tables, Nos. 7, 8, 9, 10a, 10b, and 11. The first three of these deal with the cruder forms of the metal; the next two, with manufactured articles wholly or largely composed of iron and steel, while the last table summarizes all the preceeding ones. They all cover the fiscal year ending June 30, 1906.

TABLE 7.

IRON.

IMPORTS OF IRON, PIG, SCRAP, ETC.

Fiscal Year.	Pig Iron.		Charcoal Pig Iron.		Old and Scrap Iron.		Wrought Scrap and Scrap Steel.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1880	(a) 23,159	371,956	....	....	928	14,042	....	....
1881	(a) 43,630	715,997	....	....	584	8,807	....	....
1882	56,594	811,221	6,837	211,791	1,327	20,406	....	....
1883	75,295	1,085,755	2,198	58,994	709	7,776	....	....
1884	49,291	653,708	2,893	66,602	3,136	44,223	....	....
1885	42,279	545,426	1,119	27,333	3,552	46,275	....	....
1886	42,463	528,483	3,185	60,086	10,151	158,100	....	....
1887	46,295	554,388	3,919	77,420	17,612	220,167	(b) 79	1,086
	Pig Iron, etc. (c)							
	Tons.	Value.						
		$						
1888	48,973	648,012	....	....	....	....	23,293	297,496
1889	72,115	864,752	....	....	....	....	26,794	335,090
1890	87,613	1,148,078	....	....	....	....	47,846	678,574
1891	81,317	1,085,929	....	....	....	....	43,967	652,842
1892	68,918	886,485	....	....	....	....	32,627	433,695
	Pig Iron.		Charcoal Pig Iron.		Cast Scrap Iron.			
	Tons.	Value.	Tons.	Value.	Tons.	Value.		
		$		$		$		
1893	56,849	682,209	5,944	84,358	729	9,317	45,459	574,809
1894	42,376	483,787	2,906	34,968	78	771	30,850	369,682
1895	31,637	341,259	2,780	31,171	643	4,347	23,390	244,388
1896	36,131	394,591	917	11,726	93	741	13,607	157,996
1897	25,766	291,788	2,936	35,373	238	1,362	7,903	93,541
1898	37,186	382,103	2,250	23,533	1,559	13,251	(e)48,903	534,577
1899	44,261	452,911	1,955	19,123	2,378	22,594	(e)28,352	301,268
1900	49,767	811,490	1,816	38,736	13,747	150,681	(e)38,753	638,505
1901	35,293	548,033	490	7,121	4,499	51,032	(e)24,773	242,189
1902	39,978	585,077	38	726	3,048	38,958	(e)36,150	520,909
1903	91,730	1,338,574	(f) 882	16,352	7,137	94,028	(e)43,115	670,402
1904	62,515	894,728	....	....	11,385	149,923	(e)21,027	298,806
1905	71,005	857,879	....	....	6,533	75,521	(e)15,479	210,900
1906	(d) 96,797	1,401,047	....	....	(f) 4,866	60,086	(e)21,223	326,489

(a) Comprises pig iron of all kinds.
(b) From May 13 only.
(c) These figures appear in Customs reports under heading 'Iron in pigs, Iron kentledge and cast-iron.'
(d) Includes iron kentledge. Duty $2.50 per ton.
(e) Scrap iron and scrap steel, old, and fit only to be remanufactured, being part of, or recovered from, any vessel wrecked in waters subject to the jurisdiction of Canada. Duty free.
Iron or steel scrap, wrought, being waste or refuse, including punchings, cuttings and clippings of iron or steel plates or sheets, having been in actual use, crop ends of tin plate bars, blooms and rails, the same not having been in actual use. Duty $1 per ton.
(f) Duty $2.50 per ton.

TABLE 8

IRON.

IMPORTS OF FERRO-MANGANESE, ETC.

Fiscal Year.	Tons.	Value.
*1887	123	$ 1,435
*1888	1,883	29,812
*1889	5,868	72,108
*1890	696	18,895
*1891	2,707	40,711
*1892	1,311	23,930
*1893	529	15,858
*1894	284	9,885
†1895	164	5,408
†1896	652	12,811
†1897	426	9,233
†1898	1,418	22,516
†1899	1,160	22,539
†1900	1,149	39,064
†1901	1,512	38,954
†1902	6,513	150,977
†1903	6,350	162,710
†1904	2,975	75,554
†1905	12,935	246,815
†1906 (Duty, 5 p.c.)	15,023	462,739

* These amounts include:—Ferro-manganese, ferro-silicon, spiegel, steel bloom ends and crop ends of steel rails, for the manufacture of iron or steel.

† Ferro silicon, spiegeleisen, and ferro-manganese.

TABLE 9.

IRON.

IMPORTS: IRON IN SLABS, BLOOMS, LOOPS AND PUDDLED BARS, ETC.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880	195,572	$244,601	1893	65,269	$58,533
1881	111,666	111,374	1894	50,891	45,018
1882	203,888	222,056	1895	78,639	67,321
1883	258,639	269,818	1896	128,535	110,757
1884	252,310	264,045	1897	56,560	48,954
1885	312,329	287,734	1898	162,891	122,426
1886	273,316	248,461	1899	124,311	103,198
1887	522,853	421,598	1900	255,145	362,463
1888	110,279	93,377	1901	234,925	206,975
1889	80,383	67,181	1902	401,306	419,543
1890	15,041	45,923	1903	394,418	380,034
1891	41,567	38,931	1904	200,295	216,571
1892	64,397	56,186	1905	317,829	319,665
			1906*	650,943	663,794

* Iron or steel ingots, cogged ingots, blooms, slabs, billets, puddled bars, and loops or other forms, N.O.P., less finished than iron or steel bars, but more advanced than pig iron except castings. Duty $2 per ton.

TABLE 10a.

IRON.

IMPORTS OF IRON AND STEEL GOODS.—1905-1906.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Bar iron or steel rolled, whether in coils, bundles, rods or bars, comprising rounds, ovals, squares and flats and rolled shapes, N.O.P.	Cwt.	$7 per ton.	987,429	1,541,729
Castings, iron or steel, in the rough, N.E.S.	$	25 %	....	385,792
Canada plates, Russia iron, flat galvanized iron or steel sheets, terne plates and rolled sheets of iron or steel coated with zinc, spelter or other metal, of all widths or thicknesses, N.O.P.	Cwt.	5 "	303,735	699,744
Iron or steel bridges or parts thereof, iron or steel structural work, columns, shapes or sections drilled, punched, or in any further stage of manufacture than as rolled or cast, N.E.S	"	35 "	185,678	508.346
Malleable iron castings and iron or steel castings, N.E.S.	"	25 "	4,957	16,819
Mould boards, or shares or plough plates, land sides and other plates for agricultural implements, cut to shape from rolled plates of steel but not moulded, punched, polished or otherwise manufactured	"	5 "	67,845	189,327
Iron or steel railway bars or rails of any form, punched or not punched, N.E.S., for railways, which term for the purposes of this item shall include all kinds of railways, street railways and tramways, even although the same are used for private purposes only, and even although they are not used or intended to be used in connexion with the business of common carrying of goods or passengers	Tons.	30 "	49,878	1,214,548
Railway fish-plates and tie plates	"	$8 per ton.	4,387	172,267
Rolled iron or steel angles, tees, beams, channels, joists, girders, zees, stars or rolled shapes, or trough, bridge, building, or structural rolled sections, or shapes not punched, drilled or further manufactured than rolled, N.E.S., and flat eye-bar blanks not punched or drilled	Cwt.	10 %	1,066,653	1,431,999
Rolled iron or steel hoop, band, scroll or strip, 8 inches or less in width, No. 18 gauge and thicker, N.E.S.	"	$7 per ton.	63,296	109,530
Rolled iron or steel hoop, band, scroll or strip, thinner than No. 18 gauge, N.E.S.	"	5 %	56,958	131,550
Rolled iron or steel angles, tees, beams, channels, girders and other rolled shapes or sections, weighing less than 35 lbs. per lineal yard, not punched, drilled or further manufactured than rolled, N.O.P.	"	$7 per ton.	376,692	540,013
Rolled iron or steel plates or sheets, sheared or unsheared, and skelp iron or steel, sheared or rolled in grooves, N.E.S.	"	$7 "	256,235	394.274
Rolled iron or steel plates, not less than 30 inches in width and not less than ¼ inch in thickness, N.O.P.	"	10 %	589,151	904,252
Carried forward		....	....	8,240,190

TABLE 10a—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.	Duty.	Quantity.	Value.
			$
Brought forward			8,240,190
Rolled iron or steel sheets No. 17 gauge and thinner, N.O.P. Cwt.	5 p. c.	342,850	719,180
Rolls of chilled iron or steel "	30 "	10,496	34,172
Skelp iron or steel, sheared or rolled in grooves, imported by manufacturers of wrought iron or steel pipe for use only in the manufacture of wrought iron or steel pipe in their own factories "	5 "	680,729	888,257
Swedish rolled iron and Swedish rolled steel nail rods under half an inch in diameter for the manufacture of horse-shoe nails "	15 "	20,459	42,429
Switches, frogs, crossings and intersections for railways "	30 "	13,746	55,120
Steel—chrome steel "	15 "	5,275	24,614
Steel plate, universal mill or rolled edge bridge plates imported by manufacturers of bridges "	10 "	243,768	347,360
Steel in bars, bands, hoops, scroll or strips, sheets or plates, of any size, thickness or width when of greater value than 2½c. per lb., N.O.P. "	5 "	173,240	856,354
Iron or steel beams, sheets, plates, angles, knees and cable chains for wooden, iron, steel, or composite ships or vessels "	Free.	210,753	315,664
Locomotive and car wheel tires of steel, in the rough "	"	80,365	161,914
Steel for saws and straw cutters cut to shape, but not further manufactured "	"	11,811	131,399
Crucible sheet steel, 11 to 16 gauge, 2½ to 18 inches wide, imported by manufacturers of mower and reaper knives for manufacture of such knives in their own factories "	"	10,337	42,702
Steel of No. 20 gauge and thinner, but not thinner than No. 30 gauge, for the manufacture of corset steels, clock springs and shoe shanks imported by the manufacturers of such articles for the exclusive use in the manufacture thereof in their own factories "	"	60	278
Steel valued at 2½ cents per lb. and upward, imported by the manufacturers of skates, for use exclusively in the manufacture thereof in their own factories "	"	3,592	16,007
Steel, under ½ inch in diameter, or under ½ inch square, imported by the manufacturers of cutlery, or of knobs, or of locks, for use exclusively in the manufacture of such articles in their own factories "	"	3,095	7,701
Carried forward			11,883,341

TABLE 10a—*Concluded.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
Brought forward				11,883,341
Steel, No. 12 gauge and thinner, but not thinner than No. 30 gauge, for the manufacture of buckle clasps, bed fasts, furniture casters and ice creepers, imported by the manufacturers of such articles, for use exclusively in the manufacture thereof in their own factories	Cwt.	Free.	2,099	5,379
Steel of No. 24 and 17 gauge, in sheets sixty-three inches long, and from 18 inches to 32 inches wide, imported by the manufacturers of tubular bow sockets for use in the manufacture of such articles in their own factories	"	"	1,174	2,349
Steel for the manufacture of bicycle chains, imported by the manufacturers of bicycle chain for use in the manufacture thereof in their own factories	"	"	178	680
Steel for the manufacture of files, augers auger bits, hammers, axes, hatchets, scythes, reaping hooks, hoes, hand rakes, hay or straw knives, windmills and agricultural or harvesting forks imported by the manufacturers of such or any of such articles for use exclusively in the manufacture thereof in their own factories	"	"	99,399	198,970
Steel springs for the manufacture of surgical trusses imported by the manufacturers for use exclusively in the manufacture thereof in their own factories	"	"	980	443
Flat spring steel, steel billets and steel axle bars, imported by manufacturers of carriage springs and carriage axles for use exclusively in the manufacture of springs and axles for carriages or vehicles other than railway or tramway, in their own factories	"	"	93,125	127,105
Spiral spring steel for spiral springs for railways, imported by the manufacturers of railway springs for use exclusively in the manufacture of railway spiral springs in their own factories	"	"	73,117	123,460
Steel for the manufacture of cutlery when imported by manufacturers of cutlery to be used in their own factories in the manufacture of such article, O.C	"	"	271	637
Total				12,342,364

SESSIONAL PAPER No. 26b

TABLE 10 *b*.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Agricultural implements, N.E.S., viz:—				
Cultivators and weeders	No.	20 %	3,828	26,297
Drills, grain seeders,	"	20 "	2,835	117,233
Farm, road or field rollers	"	25 "	10	204
Forks, pronged	"	25 "	8,565	5,249
Harrows	"	20 "	4,386	66,202
Harvesters, self binding	"	20 "	927	95,846
Hay loaders	"	25 "	582	26,435
Hay tedders	"	25 "	815	34,076
Hoes	"	25 "	4,902	873
Horse rakes	"	20 "	929	21,587
Knives, hay or straw	"	25 "	1,265	60
Lawn mowers	"	35 "	2,697	13,404
Manure spreaders	"	20 "	1,133	108,054
Mowing machines	"	20 "	766	24,692
Ploughs	"	20 "	17,033	477,703
Post hole diggers	"	25 "	1,485	1,326
Potato diggers	"	25 "	226	7,484
Rakes, N.E.S	"	25 "	9,620	1,822
Reapers	"	20 "	284	13,872
Scythes	Doz.	25 "	2,000	10,043
Sickles or reaping hooks	"	25 "	41	185
Spades and shovels and spade and shovel blanks, and iron or steel cut to shape for the same	"	35 "	15,113	46,762
Parts of agricultural implements paying 20 p.c.	$	20 "	....	472,771
All other agricultural implements, N.E.S.	"	25 "	....	42,384
Anvils and vises	"	30 "	....	50,792
Cart or wagon skeins or boxes	Lbs.	30 "	167,454	9,404
Springs, axles, axle bars, N. E. S., and axle blanks and parts thereof of iron or steel, for railway or tramway or other vehicles	Cwt.	35 "	68,948	143,874
Butts and hinges, N.E.S.	$	30 "	....	92,656
Cast iron pipe of every description	Cwt.	$8 per ton	343,404	447,450
Chains, coil chains, chain links and chain shackles of iron or steel 5-16 of an inch in diameter and over	"	5 %	40,617	141,639
Chain, malleable sprocket or link belting, for binders	$	20 "	....	43,988
Chains, N.E.S	"	30 "	....	99,188
Tacks, shoe	Lbs.	35 "	20,886	2,442
Cut tacks, brad sprigs, or shoe nails, double pointed, and other tacks of iron and steel, N.O.P	"	35 "	77,130	4,858
Engines, locomotives for railways, N.E.S.	No.	35 "	85	338,179
Fire engines	"	35 "	5	4,150
Fire extinguishing machines	"	35 "	....	53,298
Gasoline engines	"	25 "	2,068	405,323
Steam engines and boilers	"	25 "	1,698	596,299
Fittings, iron or steel, for iron and steel pipe	Lbs.	30 "	6,696,592	386,834
Carried forward		....	....	4,434,937

TABLE 10b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Brought forward				4,434,937
Forgings of iron or steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S., and steel shafting, turned, compressed or polished, and hammered iron or steel bars or shapes, N.O.P.	Lbs.	30 %	4,098,111	170,326
Hardware, viz:—				
Builders', cabinet-makers', upholsterers', harness-makers', saddlers' and carriage hardware, including currycombs and horse boots, N.E.S.	$	30 "		752,110
Horse, mule and ox shoes	"	30 "		14,337
Locks of all kinds	"	30 "		283,306
Machines and machinery, etc.:—				
Automobiles	No.	25 "	448	645,871
Fanning mills	"	25 "	267	3,144
Grain crushers	"	25 "	1	71
Windmills	"	25 "	909	41,934
Ore crushers and rock crushers, stamp mills, cornish and belted rolls, rock drills, air compressors, cranes, derricks and percussion coal cutters	$	25 "		206,593
Portable machines:—				
Fodder or feed cutters	No.	25 "	27	704
Horse powers	"	25 "	11	556
Portable engines	"	25 "	638	717,785
Portable saw mills and planing mills	"	25 "	73	31,382
Threshers and separators	"	25 "	652	359,986
All other portable machines	"	25 "	925	102,133
Parts of portable machines	$	25 "		142,124
Sewing machines and parts of	No.	30 "	14,138	284,189
Slot machines	"	25 "	2,388	41,603
Machines, type-writing	"	25 "	4,933	283,323
All other machinery composed wholly or in part of iron or steel, N.O.P.	$	25 "		5,331,714
Nails and spikes, composition and sheathing nails	Lbs.	15 "	11,159	1,319
Nails and spikes, wrought and pressed, trunk, clout, coopers, cigar box, Hungarian horseshoe and other nails, N.E.S.	"	30 "	207,647	14,115
Nails and spikes, cut, and railway spikes	"	½c. per lb.	2,138,075	39,278
Nails, wire of all kinds, N.O.P.	"	⅗c. "	530,275	18,318
Pumps, N.E.S.	$	25 %		261,220
Sad or smoothing, hatters' or tailors' irons, plated wholly or in part or not	"	25 "		16,718
Safes, doors for safes and vaults	"	30 "		114,131
Screws, iron and steel, commonly called 'woodscrews,' N.E.S.	Lbs.	35 "	208,823	29,481
Scales, balances, weighing beams and strength testing machines	$	30 "		134,401
Skates of all kinds and parts thereof	Pairs	35 "	86,826	49,628
Stoves of all kinds and parts thereof, N.E.S.	$	25 "		472,981
Sheets, flat, of galvanized iron or steel	Cwt.	5 "	369,580	1,101,128
Carried forward				16,100,846

TABLE 10b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Brought forward				16,100,846
Sheet iron or steel corrugated, galvanized	Cwt.	25 "	3,296	9,520
Sheet iron or steel corrugated not galvanized	"	30 "	887	2,191
Tubing:—				
Boiler tubes of wrought iron or steel, including flues and corrugated tubes for marine boilers	$	5 %		472,768
Tubes of rolled steel, seamless, not joined or welded, not more than 1½ inches in diameter	"	10 "		4,199
Tubes, seamless steel, for bicycles	"	10 "		10,214
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, over 2 inches in diameter, N.E.S.	"	15 "		554,459
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, 2 inches or less in diameter, N.E.S.	"	35 "		109,675
Other iron or steel tubes or pipes, N.O.P.	"	30 "		59,036
Ware, galvanized sheet iron or of galvanized sheet steel, manufactures of, N.O.P.	"	25 "		27,821
Ware, agate, granite or enamelled iron or steel hollow ware	"	35 "		75,935
Ware, enamelled iron or steel ware, N.E.S., iron or steel hollow ware, plain black, tinned or coated, and nickel and aluminium kitchen or household hollow ware, N.E.S	"	30 "		167,833
Wire bale ties	Bundles of 250 ties	30 "	3,743	4,932
Wire cloth or wove wire and netting of iron or steel	Lbs.	30 "	1,132,220	67,813
Wire screens, doors and windows	$	30 "		5,950
Wire fencing, woven, buckthorn strip and wire fencing of iron or steel, N.E.S.	Lbs.	15 "	1,757,932	73,068
Wire, single or several, covered with cotton, linen, silk, rubber or other material, etc., N.E.S.	"	30 "	2,223,542	355,841
Wire of all kinds, N.O.P	"	20 "	10,689,693	245,443
Wire rope, stranded or twisted wire, clothes lines, picture or other twisted wire and wire cables, N.E.S.	"	25 "	3,005,328	209,674
Iron or steel nuts, washers, rivets and bolts with or without threads and nut bolt and hinge blanks, and T. and strap hinges of all kinds, N.E.S	"	¾ c.p. lb. and 25 %	3,006,047	118,357
Pen-knives, jack-knives and pocket knives of all kinds	$	30 %		142,550
Table cutlery, all kinds, N.O.P	"	30 "		260,403
All other cutlery, N.E.S	"	30 "		335,742
Guns, rifles, including air guns and air rifles, (not being toys) muskets, cannons, pistols, revolvers, or other firearms	"	30 "		434,674
Carried forward				19,848,944

TABLE 10b—Continued.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Brought forward				19,848,944
Bayonets, swords, fencing foils and masks	"	30 "		2,487
Needles of any material or kind, not otherwise provided	"	30 "		81,415
Tools and implements :—				
Adzes, cleavers, hatchets, wedges, sledges, hammers, crow bars, cant dogs and track tools, picks, mattocks and eyes or poles for the same	$	30 %		87,025
Axes	Doz.	25 "	6,051	35,123
Saws	$	30 "		206,528
Files and rasps, N.E.S.	"	30 "		88,211
Tools, hand or machine, of all kinds, N.O.P	"	30 "		119,661
Knife blades, or blanks, and forks of iron or steel, in the rough, not handled, filed, ground or otherwise manufactured	"	10 "		70
Manufactures : articles or wares not specially enumerated or provided for, composed wholly or in part of iron or steel, and whether partly or wholly manufactured.	"	30 "		3,017,901
Anchors	Cwt.	Free	4,795	18,043
Iron or steel, rolled round wire rods, in the coil not over ⅜-inch in diameter, imported by wire manufacturers for use in making wire in the coil in their own factories	"	"	376,220	478,991
Iron or steel masts, or parts of	"	"	18	367
Rolled iron tubes not welded, or joined, under 1½ inch in diameter, angle iron 9 and 10 gauge, not over 1½ inch wide, iron tubing lacquered or brass covered, not over 1½ inch diameter, all of which are to be cut to lengths for the manufacture of bedsteads, and to be used for no other purpose, and brass trimmings for bedsteads imported for the manufacture of iron or brass bedsteads	"	"		212,340
Steel bowls for cream separators, and cream separators	$	"		625,510
Cream separators : articles for the construction or manufacture of—when imported by manufacturers of cream separators to be used in their own factories for the manufacture of cream separators, O.C.	"	"		95,578
Steel strip and flat steel wire imported by manufacturers of buckthorn and plain strip fencing, for use in their own factories in the manufacture thereof	"	"	80	277
Carried forward				25,818,471

TABLE 10b—*Concluded.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year, 1906.		Duty.	Quantity.	Value.
				$
Brought forward				25,818,471
Steel wire, Bessemer soft drawn spring of Nos. 10, 12 and 13 gauge respectively, and homo steel spring wire of Nos. 11 and 12 gauge, respectively, imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	Free.	3,675	9,186
Machinery and structural iron for beet root sugar factories	$	"		7,043
Flat steel wire of No. 16 gauge or thinner imported by the manufacturers of crinoline, corset wire and dress stays, for use in the manufacture of such articles in their own factories	Cwt.	"	3,885	22,451
Wire, crucible cast steel	Lbs.	"	2,427,406	115,541
Galvanized iron or steel wire Nos. 9, 12 and 13 gauge	Cwt.	"	545,339	1,076,589
Barbed fencing wire of iron and steel	"	"	446,212	929,660
Total				27,998,941

TABLE 11.

IRON.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, ETC., FISCAL YEAR, 1905-1906.

Recapitulation of Tables, 7, 8, 9, 10a and 10b.

——	Tons.	Value.
Pig iron	96,797	$1,401,047
Pig iron, charcoal		
Scrap iron, cast	4,866	60,086
Scrap steel, wrought	21,223	326,489
Ferro-manganese, etc	15,023	462,739
Iron in slabs, blooms, puddled bars, etc	32,547	663,794
Iron and steel goods partially manufactured		12,342,364
Iron and steel goods more highly manufactured*		27,978,941
Total		43,235,480

* Machinery, etc., classed under iron and steel goods in Customs report.

LEAD.

The total production of lead in Canada in 1906 was 54,608,217 pounds, valued at $3,089,187 or 5·657 cents per pound, the final New York value of refined lead. Compared with the previous year the production in 1906 shows a slight falling off, the decrease being 2,256,698 pounds or about 3·9 per cent. Although a small amount of lead is annually mined in Ontario, the great bulk of the output has been derived from the silver lead ores of East and West Kootenay, British Columbia. The lead industry has by no means enjoyed continuous prosperity. A maximum output was reached in 1900, with a production of 63,169,821 pounds; in 1903 the output had diminished to 18,139,283 pounds, though in the following years a rapid increase again occurred.

In 1901, and again in 1903, the Dominion Government, to encourage the lead industry, authorized the payment of a bounty on the production of lead. The act of 1903 provided for the payment under certain restrictions of seventy-five cents per hundred pounds on lead contained in ore mined in Canada, provided that when the standard price of pig lead in London, England, exceeds twelve pounds ten shillings per ton of 2240 pounds, such bounty shall be reduced proportionately by the amount of such excess. Thus, when the price of lead in London rises to £16 or over per long ton, the bounty ceases. As the price of lead exceeded £16 sterling on the London market for a considerable period during 1906, the total amount of bounty paid was only $40,541, as compared with $334,224 in 1905.

The average monthly price of lead on the New York market during 1906 was 5·657 cents per pound, as compared with 4·707 cents in 1905, or an increase of 0·950 cents or 20 per cent.

The following is a statement of the average monthly prices of lead during 1906 as published by the Engineering and Mining Journal of New York:—

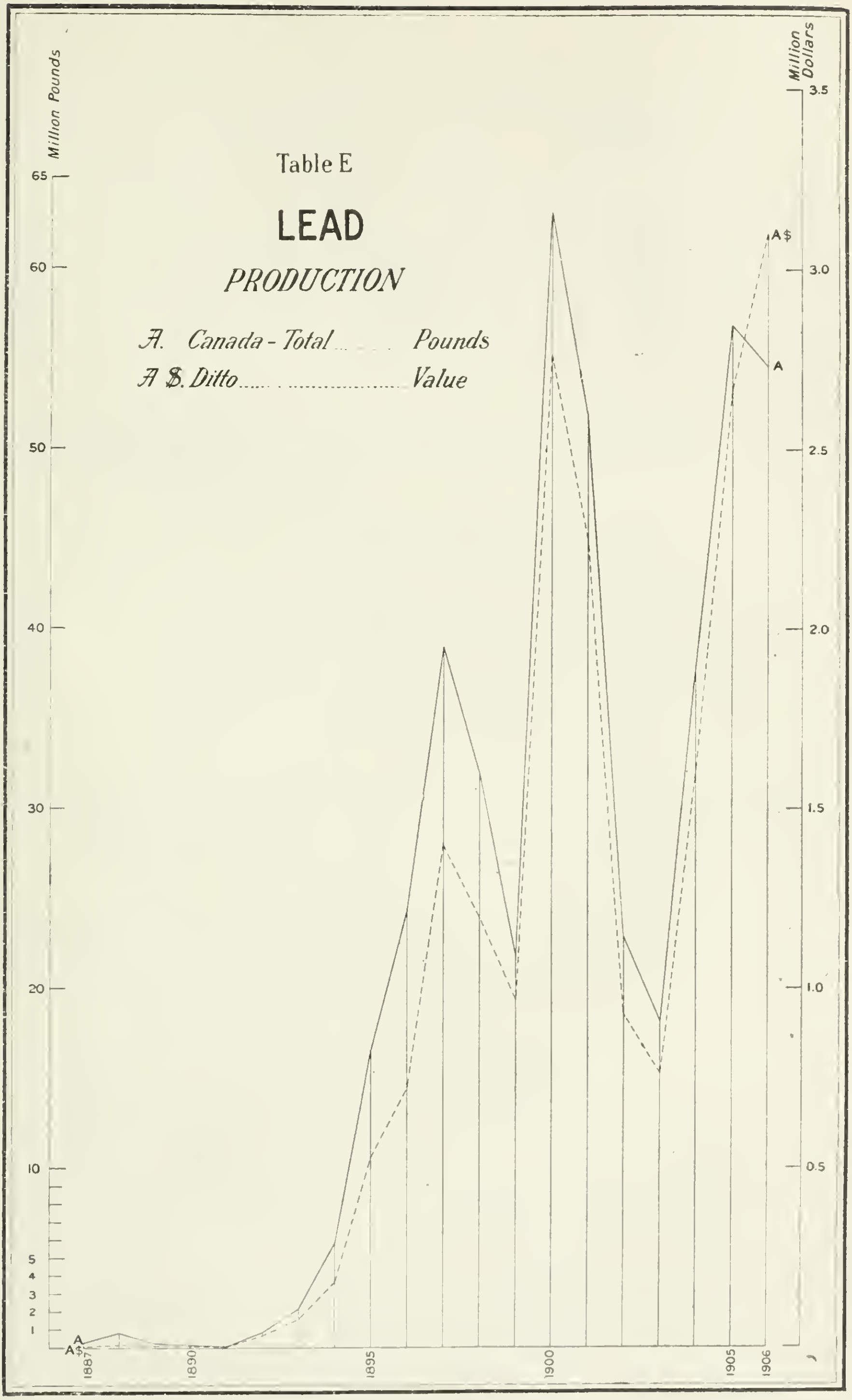


Table E
LEAD
PRODUCTION
A. Canada - Total .... Pounds
A $. Ditto .... Value
Million Pounds
Million Dollars
65
60
50
40
30
20
10
5
4
3
2
1
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1887
1890
1895
1900
1905
1906
A
A$

MONTHLY AVERAGE PRICE OF LEAD DURING 1906 IN NEW YORK.

Month.	Cents per Pound.	Month.	Cents per Pound.
January	5·600	July	5·750
February	5·464	August	5·750
March	5·350	September	5·750
April	5·404	October	5·750
May	5·685	November	5·750
June	5·750	December	5·900
		Average for the year	5·657

The monthly average prices of soft lead in London, England—as published by Julius Matton of London, and Metallgesellschaft of Frankfort—were, during 1906, as follows :—

MONTHLY AVERAGE PRICES OF SOFT LEAD DURING 1906 IN LONDON, ENG.*

January	£16	17	6	July	£16	11	7
February	16	0	3	August	17	1	3
March	15	17	8	September	18	4	4
April	15	16	6	October	19	7	9
May	16	13	6	November	19	5	6
June	16	15	6	December	19	12	6
				Average for the year	£17	7	0

Previous to 1904 lead ores mined in Canada were either exported or were reduced in Canadian furnaces to lead bullion carrying gold, silver, etc., which product was then exported for further treatment.

A lead refinery, however, is now being operated at Trail, B.C., by the Consolated Mining and Smelting Company of Canada, producing pig lead, lead pipe, sheet lead, etc., of exceptional purity. The production of refined lead by this firm has been as follows :—

Year.	Refined Lead produced.
1904	7,519,440 pounds
1905	15,804,509 "
1906	20,471.314 "

Thus in 1906 a little over 37 per cent of the output was refined in Canada, as compared with 27 per cent in 1905 and 20 per cent in 1904.

The Carter White Lead Co., of Canada, Ltd., manufacturers of white lead at Montreal, use Trail lead exclusively. Their plant is equipped for an immediate capacity of 7,000 tons per annum ; but is designed for an ultimate capacity of 15,000 tons.

TABLE 1.

LEAD.

ANNUAL PRODUCTION.

Calendar Year.	Pounds.	Price per Pound.	Value.
		cts.	
1887	204,800	4·50	$ 9,216
1888	674,500	4·42	29,812
1889	165,100	3·93	6,488
1890	105,000	4·48	4,704
1891	88,665	4·35	3,857
1892	808,420	4·09	33,064
1893	2,135,023	3·73	79,636
1894	5,703,222	3·29	187,636
1895	16,461,794	3·23	531,716
1896	24,199,977	2·98	721,159
1897	39,018,219	3·58	1,396,853
1898	31,915,319	3·78	1,206,399
1899	21,862,436	4·47	977,250
1900	63,169,821	4·37	2,760,521
1901	51,900,958	4·334	2,249,387
1902	22,956,381	4·069	934,095
1903	18,139,283	4·237	768,562
1904	37,531,244	4·309	1,617,221
1905	56,864,915	4·707	2,676,632
1906	54,608,217	5·657	3,089.187

EXPORTS AND IMPORTS: —According to Customs Department statistics exports of lead during 1906 were as follows :—

—	Pounds.	Value.
Lead in ore, etc.	18,140,671	$622,101
Pig Lead	3,295,351	113,906
Total	21,436,022	$736,007

Lead in ore was exported chiefly to the United States, while the pig lead exported was shipped principally to Japan, China, and Australia.

Imports of lead in the shape of old, scrap, pig, block, bars, and sheets amounted to 4,941 tons; tea lead nearly 1,000 tons, manufactures of lead (quantity not stated) valued at $75,619 ; litharge, which is about 92 per cent lead, 508 tons, and 5,206 tons of white and red lead, etc., or a total of a little over 11,500 tons ; besides $75,619 worth of manufactured lead products.

TABLE 2.

LEAD.

EXPORTS.

Calendar Year.	Value.
1873	$1,993
1874	127
1875	7,510
1876	66
1877	720
1878	....
1879	230
1880	....
1881	....
1882	32
1883	5
1884	36
1885	....
1886	....
1887	724
1888	18
1889	....
1890	....
1891	5,000
1892	2,509
1893	3,099
1894	144,509
1895	435,071
1896	462,095
1897	925,144
1898	885,485
1899	466,950
1900	1,917,690
1901	1,804,687
1902	457,170
1903	426,466
1904	559,461
1905	1,046,541
1906	736,007

TABLE 3.

LEAD.

IMPORTS OF LEAD.

Fiscal Year.	Old, Scrap and Pig.		Bars, Blocks, Sheets.		Total.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1880	....	....	....	....	30,298	$124,117
1881	16,236	$ 56,919	18,222	$70,744	34,458	127,663
1882	36,655	120,870	10,540	35,728	47,195	156,598
1883	48,780	148,759	8,591	28,785	57,371	177,544
1884	39,409	103,413	9,704	28,458	49,113	131,871
1885	36,106	87,038	9,362	24,396	45,468	111,434
1886	39,945	110,947	9,793	28,948	49,738	139,895
1887	61,160	173,477	14,153	41,746	75,313	215,223
1888	68,678	196,845	14,957	45,900	83,635	242,745
1889	74,223	213,132	14,173	43,482	88,396	256,614
1890	101,197	283,096	19,083	59,484	120,280	342,580
1891	86,382	243,033	15,646	48,220	102,028	291,253
1892	97,375	254,384	11,299	32,368	108,674	286,752
1893	94,485	215,521	12,403	32,286	106,888	247,807
1894	70,223	149,440	8,486	20,451	78,709	169,891
1895	67,261	139,290	6,739	16,315	74,000	155,605
1896	72,433	173,162	8,575	23,169	81,008	196,331
1897	65,279	158,381	10,516	29,175	75,795	187,556
	Old, Scrap, Pig and Block.*		Bars and Sheets.†		Total.	
1898	88,420	$260,779	22,214	$39,041	110,634	$299,820
1899	114,659	283,432	44,796	39,833	159,455	323,265
1900	62,361	207,819	15,493	53,506	77,854	251,325
1901	(a)85,321	97,011	16,295	78,316	101,616	175,327
1902	(a)122,279	104,672	18,596	49,261	140,875	153,933
1903	(a)98,530	67,821	11,535	35,398	110,065	103,219
1904	(a)94,602	121,165	14,102	39,644	108,704	160,809
1905	(a)57,074	133,775	17,792	51,972	74,866	185,747
1906	82,729	271,105	16,106	57,185	98,835	328,290

* Duty 15 per cent.
† Duty 25 per cent.
(a) Includes Canadian lead ore sent to the United States for refining, imported at price of refining only.

TABLE 4.

LEAD.

IMPORTS OF LEAD MANUFACTURES.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 15,400	1893	$ 33,783
1881	22,629	1894	29,361
1882	17,282	1895	38,015
1883	25,556	1896	50,722
1884	31,361	1897	60,735
1885	36,340	1898	63,179
1886	33,078	1899	91,497
1887	19,140	1900	194,736
1888	18,816	1901	107,260
1889	16,315	1902	120,020
1890	25,600	1903	134,151
1891	23,893	1904	129,093
1892	22,636	1905	147,177

	Duty.	Cwt.	
1906 Lead Tea	Free.	19,050	$ 79,886
" Pipe	35 p. c.	877	5,417
" Shot and bullets	35 "	728	2,871
Manufactures, N.E.S.	30 "	.....	75,619
Total	.....	.....	$163,793

TABLE 5.

LEAD.

IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880	3,041	$14,334	1894	38,547	$28,685
1881	6,126	22,129	1895	11,955	32,953
1882	4,900	16,651	1896	10,710	32,817
1883	1,532	6,173	1897	12,028	34,538
1884	5,235	18,132	1898	11,446	32,904
1885	4,990	16,156	1899	9,530	32,518
1886	4,928	16,003	1900	9,139	29,176
1887	6,397	21,865	1901	11,132	51,944
1888	7,010	23,808	1902	13,002	47,021
1889	8,089	31,082	1903	13,921	47,761
1890	9,453	31,401	1904	9,894	32,633
1891	7,979	27,613	1905	17,865	57,736
1892	10,384	34,343	1906.. Duty free...	10,165	39,836
1893	7,685	24,401			

TABLE 6.

LEAD.

IMPORTS OF DRY WHITE AND RED LEAD AND ORANGE MINERAL.

	Fiscal Year.	Pounds.	Value.
a	1885	5,404,753	$ 198,913
a	1886	6,703,077	213,258
a	1887	6,998,820	233,725
a	1888	6,361,334	216,654
a	1889	7,066,465	267,236
b	1890	10,859,672	381,959
b	1891	8,560,615	337,407
b	1892	10,288,766	351,686
b	1893	10,865,183	364,680
b	1894	10,958,170	353,053
b	1895	8,780,052	282,353
b	1896	11,711,496	367,569
b	1897	10,310,463	347,539
b	1898	12,682,808	448,659
b	1899	14,507,945	514,842
b	1900	14,679,920	634,492
b	1901	10,241,601	461,368
b	1902	15,584,164	603,582
b	1903	19,208,786	758,371
b	1904	16,925,585	662,098
(c)	1905 . . Duty 5 per cent.	17,376,588	638,381

		Duty.	Pounds.	Value.
1906	White lead, dry	30 %	8,248,057	$336,142
1906	" " ground in oil	35 %	270,920	12,533
1906	Red lead and orange mineral	5 %	1,893,914	68,769
	Total		10,412,891	417,444

(a) Imports of dry white and red lead and orange mineral.
(b) Imports of dry white and red lead, orange mineral and zinc white.
(c) Imports of dry white and red lead.

British Columbia :—Statistics of lead production in British Columbia, comprising the greater part of the output in Canada, are given separately in table 7, while the details by districts for the past four years are given in table 8. The largest production recorded for one year was in 1900, and the second largest in 1905. The production in 1906 was less than the production in 1905 by about 7·3 per cent.

TABLE 7.

LEAD.

BRITISH COLUMBIA :—PRODUCTION.

Calendar Year.	Pounds.	Price per Pound.	Value.
		cts.	
1887	204,800	4·50	$ 9,216
1888	674,500	4·42	29,813
1889	165,100	3·93	6,488
1890	Nil.	....	....
1891	"	....	....
1892	808,420	4·09	33,064
1893	2,131,092	3·73	79,490
1894	5,703,222	3·29	187,636
1895	16,461,794	3·23	531,716
1896	24,199,977	2·98	721,159
1897	38,841,135	3·58	1,390,513
1898	31,693,559	3·78	1,198,017
1899	21,862,436	4·47	977,250
1900	63,158,621	4·37	2,760,031
1901	51,582,906	4·334	2,235,603
1902	22,536,381	4·069	917,005
1903	18,089,283	4·237	766,443
1904	36,646,244	4·309	1,579,086
1905	56,580,703	4·707	2,663,254
1906	52,408,217	5·657	2,964,733

TABLE 8.

LEAD.

BRITISH COLUMBIA :—PRODUCTION BY DISTRICTS.

——	1903.	1904.	1905.	1906.
	Pounds.	Pounds.	Pounds.	Pounds.
Cassiar	....	....	5,500	....
East Kootenay				
Fort Steele	717,479	21,071,236	48,248,828	44,487,481
Other districts	951,296	401,022	149,584	167,691
West Kootenay	4,299,727	3,091,648	1,002,114	3,173,353
Ainsworth	1,072,542	976,570	1,368,388	1,034,553
Nelson	9,880,469	10,611,227	5,399,330	2,975,674
Slocan	1,144,239	485,520	339,883	469,006
Other districts	23,531	9,021	67,076	100,465
Yale	18,089,283	36,646,244	56,580,703	52,408,217

NICKEL.

The production of nickel from the ores of the Sudbury district in Ontario has made a very rapid growth during the past two years, the output in 1906 being over twice that of 1904. The ore is smelted at Copper Cliff and Victoria Mines to a matte carrying from 78 to 80 per cent of the combined metals, copper and nickel. The resulting matte is shipped to the United States and Great Britain for refining.

The quantity of nickel contained in the matte shipped during 1906 was 21,490,955 pounds, as compared with 18,876,315 pounds in 1905, or an increase of 2,614,640 pounds, or 13·851 per cent. The total amount of matte shipped was 20,310 tons, containing both nickel and copper, and was valued at the point of shipment at about $4,628,011. The final value of the refined nickel in New York at an average of 41·64 cents per lb. would be $8,948,834.

The following were the aggregate results of operations on the nickel-copper deposits of Ontario in 1906 :—

	Tons of 2,000 lbs.
Ore mined	343,814
Ore smelted	340,059
Matte produced	20,364
Matte shipped	20,310
Copper contents of matte shipped	5,264
Nickel contents of matte shipped	10,745
Spot value of matte shipped	$4,628,011

According to customs returns, exports of nickel in matte, etc., were for twelve months ending December 31, as follows :—

	Pounds.
To Great Britain	2,716,892
To United States	17,936,953
	20,653,845

During 1905 the price of refined nickel remained fairly steady throughout the year; according to the "Engineering and Mining Journal" of New York, quotations for large lots, New York or other parallel delivery, were 40 to 47 cents per pound, according to size and condition of order. For small quantities prices ranged from 48 to 60 cents, also according to size of order and delivery.

In 1906 the price of refined nickel, according to the same monthly, remained fairly steady from January to September 8, quotations for


Table F
NICKEL
PRODUCTION
A. Canada. Pounds
A $ Ditto.. Value
Million Pounds
Million Dollars
A
A$
1889
1890
1895
1900
1905
1906

265—6

large lots, New York delivery, being from 40 to 45 cents per pound. From September 1 to the end of the year quotations were from 45 to 50 cents per pound according to size and condition of order, while for small quantities prices were from 50 to 65 cents per pound.

Although nickel is one of the minor constituents of the rich silver ores of the Cobalt district, statistics of the quantities of this mineral contained in these ores have not been included in the accompanying tables.

The Ontario Bureau of Mines reports the quantity of nickel contained in ore shipped from Cobalt as follows :—

Year.	Tons of Nickel.
1904	14
1905	75
1906	160

The companies engaged in mining nickel ores are as follows :

The Canadian Copper Company (The International Nickel Co.) Copper Cliff, Ont., and New York.

The Mond Nickel Company, Victoria Mines, Ont., and London, Eng.

The Lake Superior Power Company, (The Lake Superior Corporation) Sault Ste Marie, Ont.

The latter Company did not operate their nickel mines during the year.

TABLE 1.

NICKEL.

ANNUAL PRODUCTION.

Calendar Year.	Pounds of Nickel in Matte.	Final Average Market Price per lb at New York.	Value.
1889	*830,477	60c.	$ 498,286
1890	1,435,742	65c.	933,232
1891	4,035,347	60c.	2,421,208
1892	2,413,717	58c.	1,399,956
1893	3,982,982	52c.	2,071,151
1894	4,907,430	38$\frac{1}{8}$c.	1,870,958
1895	3,888,525	35c.	1,360,984
1896	3,397,113	35c.	1,188,990
1897	3,997,647	35c.	1,399,176
1898	5,517,690	33c.	1,820,838
1899	5,744,000	36c.	2,067,840
1900	7,080,227	47c.	3,327,707
1901	9,189,047	50c.	4,594,523
1902	10,693,410	47c.	5,025,903
1903	12,505,510	40c.	5,002,204
1904	10,547,883	40c.	4,219,153
1905	18,876,315	40c.	7,550,526
1906	21,490,955	41.64	8,948,834

*Calculated from shipments made by rail.

TABLE 2.

NICKEL.

EXPORTS.*

Calendar year.	Value.	Calendar Year.	Value.
1890	$ 89,568	1899	$939,915
1891	667,280	1900	1,031,030
1892	293,149	1901	751,080
1893	629,692	1902	1,007,211
1894	559,356	1903	1,116,099
1895	521,783	1904	1,091,349
1896	658,213	1905	1,569,693
1897	723,130	1906	2,042,065
1898	1,019,363		

*Practically all the nickel-bearing ore and matte produced in Canada is exported, the apparent discrepancy between tables Nos. 1 and 2 being due to the different basis of valuation adopted in the two instances. Table 1 represents the total final values of the nickel produced in Canada, for the years represented. In table 2 the worth of the product shipped is entered at its spot value to the operators, and depends upon the particular stage to which they happen to carry the process of extraction at the time, *e.g.*, whether the shipments made are raw ore, low grade matte or high grade matte, etc.

TABLE 3.

NICKEL.

IMPORTS.

Calendar Year.		Value.
1890		$ 3,154
1891		3,889
1892		3,208
1893		2,905
1894		3,528
1895		4,267
1896		4,787
1897		4,737
1898		5,882
1899		9,449
1900		6,988
1901		12,029
1902		15,448
1903		26,177
1904		14,682
1905		19,076
	Duty.	
1906 { Nickel anodes	10 p. c.	15,976
1906 { Nickel*	Free.	
		$ 15,976

*Classified under the general heading of minerals in the Trade and Navigation Report.

ZINC.

The zinc smelting plant erected at Frank, Alberta, by the Canadian Metal Company, Ltd., has not yet been put into commercial operation, and there is as yet no production of spelter in Canada.

Small amounts of zinc ore and concentrates were shipped both from Ontario and British Columbia, the total being 1,154 tons, valued at $23,800.

The production in Ontario was derived from the Richardson mine in the township of Olden, Frontenac county.

For British Columbia the Provincial Mineralogist reports in the Minister of Mines report as follows:

"The production of zinc ore this past year was very small, only some 654 tons, and the industry has been practically at a stand still. In 1905, concentrating or "enriching" plants were erected for the production of concentrates that would assay about 50 per cent zinc, for which there was a market in the United States, into which country they were admitted free of duty as "crude mineral"; but in 1906 a decision of the United States Customs Department ruled that these concentrates were not "crude mineral" and, consequently, were subject to duty, which duty was so high as to be prohibitive, the result being a suspension of zinc mining in British Columbia. This decision has, however, been appealed from, and on February 7, 1907, the United States General Appraisers reversed the decision, deciding that these concentrates were "crude mineral" and, consequently, free from duty."

Table 1.

Zinc.

Annual Production of Zinc.

Calendar Year.	Zinc Ore Shipped		Metallic Zinc in Ore Shipped.	
	Tons.	Spot Value.	Pounds.	Final Value.
1898	1.162	$ 11,000	788,000	$ 36,011
1899	865	18,165	814,000	46,805
1900	261	1,810	212,000	9,342
1901	....	....	....	....
1902	158	1.659	142,200	6,882
1903	1,000	10,500	900,000	48,660
1904	597	3,700	477,568	24,356
1905	9,413	139,200	*	*
1906	1;154	23,800	*	*

*Figures not available.

TABLE 2.

ZINC.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880	13,805	$67,881	1894	20,774	$90,680
1881	20,920	94,015	1895	15,061	63,373
1882	15,021	76,631	1896	20,223	80,784
1883	22,765	94,799	1897	11,946	57,754
1884	18,945	77,373	1898	35,148	112,785
1885	20,954	70,598	1899	18,785	107,477
1886	23,146	85,599	1900	28,748	156,167
1887	26,142	98,557	1901	20,527	103,457
1888	16,407	65,827	1902	34,871	141,560
1889	19,782	83,935	1903	26,646	142,827
1890	18,236	92,530	1904	25,553	138,057
1891	17,984	105,023	1905	25,141	141,514
1892	21,881	127,302	1906 Duty free	24,462	158,438
1893	26,446	124,360			

TABLE 3.

ZINC.

IMPORTS OF SPELTER.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880	1,073	$5,310	1894	8,423	$35,615
1881	2,904	12,276	1895	9,249	30,245
1882	1,654	7,779	1896	10,897	40,548
1883	1,274	5,196	1897	8,342	32,826
1884	2,239	10,417	1898	2,794	13,561
1885	3,325	10,875	1899	5,450	29,687
1886	5,432	18,238	1900	5,836	29,416
1887	6,908	25,007	1901	14,621	58,283
1888	7,772	29,762	1902	18,356	80,757
1889	8,750	37,403	1903	23,159	110,817
1890	14,570	71,122	1904	33,952	164,751
1891	6,249	31,459	1905	37,941	206,244
1892	13,909	62,550	1906 Duty free	50,137	290,686
1893	10,721	49,822			

*Spelter in blocks and pigs.

TABLE 4.

ZINC.

IMPORTS OF ZINC, MANUFACTURES OF.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 8,327	1893	7,464
1881	20,178	1894	6,193
1882	15,526	1895	5,581
1883	22,599	1896	6,290
1884	11,952	1897	5,145
1885	9,459	1898	10,503
1886	7,345	1899	14,661
1887	6,561	1900	11,475
1888	7,402	1901	6,882
1889	7,233	1902	6,683
1890	6,472	1903	9,754
1891	7,178	1904	12,682
1892	7,563	1905	11,912

	Duty.	
1906 Zinc seamless drawn tubing	Free.	....
1906 " manufactures of, N.O.P	25 %	$ 12,917
Total		$ 12,917

MISCELLANEOUS METALLIC.

ALUMINIUM.

The Northern Aluminium Company have extensive works at Shawenegan Falls, Que., where they manufacture aluminium from ores imported from France and Germany. They have also a well equipped wire mill where the metal is made into aluminium wire and cables which are now used extensively in transmission of electricity. No Canadian raw material is used ; but it is interesting to mention the industry inasmuch as it may stimulate search and prospecting for ores of aluminium. The Northern Aluminium Company use bauxite imported from France and Germany.

ANTIMONY.

The mining of antimony ores in Canada has been exceedingly irregular, as previous to 1905 no production had been reported since 1898. In 1905 about 527 tons of ore were shipped from West Gore, Hants county, Nova Scotia, and in 1906 the shipments were 782 tons, yielding 1,031 ozs. 13 dwt. 11 grs. gold ; antimony contents not stated.

An important discovery of antimony ore was made in British Columbia and is referred to in the report of the Minister of Mines as follows :—

"The most notable discovery in the district (Slocan district) was that of a large body of stibnite in the Alps and Alturas claims, on the north fork of Carpenter creek. The ore shows in a well defined ledge four feet in width, running 65 p.c. antimony. The owners of the property, The Golden Crown Gold and Silver Mining Company, Louis Hind, M.E., manager, owing to the lateness of the season and the elevation of the mines, viz., 7,700 feet, were unable to do more than development work during the fall ; but sufficient progress was made to show that the ore body is a very extensive one. A car load of ore is now sacked on the dump and a large quantity of ore is blocked out ready for mining. The management has arranged for the construction of an aerial tramway 4,000 feet in length, and for the building of substantial quarters for a large force of men, that operations may be carried on continuously. The ore is to be sent to Scotland for treatment, and shipments will be made as soon as the tramway is installed."

TABLE 1.

MISCELLANEOUS.

METALLIC.

ANNUAL PRODUCTION OF ANTIMONY ORE.

Calendar Year.	Tons.	Value.
1886	665	$31,490
1887	584	10,860
1888	345	3,696
1889	55	1,100
1890	26½	625
1891	10	60
1892 to 1897	Nil.	Nil.
1898	1,344	20,000
1899 to 1904	Nil.	Nil.
1905	527	...
1906	782	...

* Fiscal year ending September 30.

TABLE 2.

MISCELLANEOUS.

METALLIC.

EXPORTS OF ANTIMONY ORES.

Calendar Year	Tons.	Value.	Calendar Year	Tons.	Value.
1880	40	$1,948	1891	3½	$60
1881	34	3,308	1892 to 1897	Nil.	Nil.
1882	323	11,673	1898	1,232	15.295
1883	165	4,200	1899	6¾	190
1884	483	17,875	1900	210	3,441
1885	758	36,250	1901	10	1,643
1886	665	31,490	1902	90	13,658
1887	229	9,720	1903	33	4,332
1888	352½	6,894	1904	160	7,237
1889	30	695	1905	525	27,118
1890	38	1,000	1906	420	17,064

TABLE 3.

MISCELLANEOUS.

METALLIC.

IMPORTS OF ANTIMONY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	42,247	$ 5,903	1893	181,823	$14,771
1881	....	7,060	1894	139,571	12,249
1882	183,597	15,044	1895	79,707	6,131
1883	105,346	10,355	1896	163,209	9,557
1884	445,600	15,564	1897	134,661	8,031
1885	82,012	8,182	1898	156,451	12,350
1886	89,787	6,951	1899	289,066	16,851
1887	87,827	7,122	1900	186,997	20,001
1888	120,125	12,242	1901	350,737	24,714
1889	119,034	11,206	1902	504,822	39,276
1890	117,066	17,439	1903	868,146	65,434
1891	114,084	17,483	1904	418,943	27,112
1892	180,308	17,680	1905	186,454	12,828

		Duty.		
1906	Antimony, or regulus of, not ground, pulverized or otherwise manufactured.	Free.	316,278	42,517
	Antimony salts	"	87,640	13,780
	Total	....	403,918	56,297

MERCURY.

There has been no production of mercury since 1897. The small production reported in 1895, 1896 and 1897, was derived from the deposits at the western end of Kamloops lake, B.C. These deposits consist of quartz veins containing pockets of cinnabar. These veins are in a zone of decomposed volcanic rock of Tertiary age.

TABLE 4.

MISCELLANEOUS.

METALLIC.

PRODUCTION OF MERCURY.

Calendar Year.	Flasks ($76\frac{1}{2}$ lb.)	Price per flask.	Value.
1895	71	$ 33 00	$ 2,343
1896	58	33 44	1,940
1897	9	36 00	324

TABLE 5.

MISCELLANEOUS.

METALLIC.

IMPORTS OF MERCURY.

Fiscal Year.	Pounds.	Value.
1882	2,443	$ 965
1883	7,410	2,991
1884	5,848	2,441
1885	14,490	4,781
1886	13,316	7,142
1887	18,409	10,618
1888	27,951	14,943
1889	22,931	11,844
1890	15,912	7,677
1891	29,775	20,223
1892	30,936	15,038
1893	50,711	22,998
1894	36,914	14,483
1895	63,732	25,703
1896	77,869	32,343
1897	76,058	33,534
1898	59,759	36,425
1899	103,017	51,695
1900	85,342	51,987
1901	140,610	94,564
1902	97,283	56,615
1903	164,968	91,625
1904	151,107	80,658
1905	103,330	48,412
1906 ...... Duty free.	150,364	69,505

PLATINUM.

The chief source of the platinum production in Canada has been the placer gravels of British Columbia, principally in the Similkameen River district. The nickel-copper ores of the Sudbury district also carry small quantities of the metals of the platiuum group, and these are now being partly recovered. During 1902, 1903, and 1904 considerable quantities of platinum were recovered from accumulated residues resulting from the treatment of the mattes from Sudbury.

In 1906 there was practically no production of platinum from placer deposits, while the amount of platinum metals recovered from the treatment of the nickel-copper mattes is reported by the Ontario Bureau of Mines to have been 314 ounces valued at $5,652. This has been tabulated under palladium.

In British Columbia the Provincial Mineralogist reports that "Platinum continues to be found in small quantities in various parts of the Province, but as yet no systematic attempt has been made to save it. As already noted in previous reports, it is found in alluvial washings in the Similkameen district, on the Quesnel river in Cariboo, on Thibert creek in Cassiar, and also in the Yukon. The latest find was at Lillooet, from which district there was received a few ounces of the crude platinum sand, saved by a prospector in washing for gold, for which the Provincial Mineralogist was able to obtain some $25 an ounce net cash."

TABLE 6.

MISCELLANEOUS.

METALLIC.

ANNUAL PRODUCTION OF PLATINUM.

Calendar Year.	Value.	Calendar Year.	Value.
1887	$ 5,600	1897	$ 1,600
1888	6,000	1898	1,500
1889	3,500	1899	825
1890	4,500	1900	Nil.
1891	10,000	1901	457
1892	3,500	1902	46,502
1893	1,800	1903	33,345
1894	950	1904	10,872
1895	3,800	1905	500
1896	750	1906	*

* See under Palladium.

TABLE 7.

MISCELLANEOUS.

METALLIC.

IMPORTS OF PLATINUM.

Fiscal Year.	Value.	Fiscal Year.	Value.
1883	$ 113	1895	$3,937
1884	576	1896	6,185
1885	792	1897	9,031
1886	1,154	1898	9,781
1887	1,422	1899	9,671
1888	13,475	1900	57,910
1889	3,167	1901	20,263
1890	5,215	1902	19,357
1891	4,055	1903	21,251
1892	1,952	1904	28,112
1893	14,082	1905	61,719
1894	7,151	1906*	54,494

*Platinum wire and platinum in bars, strips, sheets or plates, platinum retorts, pans, condensers, tubing and pipe, imported by manufacturers of sulphuric acid for use in their works. Duty free.

PALLADIUM,

It has been known for a long time that palladium was present in the nickel ore of the Sudbury district, but in past years no definite information could be obtained as to whether the metals of the platinum group were saved in the treatment which the ores and mattes underwent. As far back as 1889 it was discovered that sperrylite, the arsenide of platinum, which is present in the Sudbury ores, contained traces of palladium, but the occurrence was noted as being only of mineralogical interest. Of late years, however, the sources of platinum have not been able to supply the demand, and palladium is being considered as a possible substitute on account of its malleability and high melting point (palladium 1500°C, platinum 1750°C).

The metal palladium, as well as platinum, as already explained, has been recovered from the residues resulting from the treatment of the nickel-copper ores of Sudbury, Ont., and statistics of production as obtained by the Ontario Bureau of Mines have been as follows :—

		Ounces.	Value.
1902	Palladium	4,411	$86,014
1903	"	3,177	61,952
1904	"	952	18,564
1905	Metals of the Platinum Group	1,562	28,116
1906	" " "	314	5,652

TIN.

Tin ores have not yet been found in sufficient quantities in Canada to be of economic importance.

The occurrence of tin has been reported from several localities, the most important, perhaps, being the recent discovery of cassiterite near New Ross, Lunenburg county, Nova Scotia. This occurrence has not yet been found of economic value. It has been visited by several officers of the Geological Survey, and reports upon it may be found in the Summary Report of the Geological Survey Branch of the Department of Mines for 1907, pages 77 and 80 to 83.

The imports of tin and manufactures of, into Canada, are shown in the following table :—

TABLE 8.

MISCELLANEOUS.

METALLIC.

IMPORTS OF TIN AND TINWARE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$ 281,880	1893	$1,242,994
1881	413,924	1894	1,310,389
1882	790,285	1895	973,397
1883	1,274,150	1896	1,237,684
1884	1,018,493	1897	1,274,108
1885	1,060,883	1898	1,550,851
1886	1,117,368	1899	1,372,813
1887	1,187,312	1900	2,418,455
1888	1,164,273	1901	2,339,109
1889	1,243,794	1902	2,293,958
1890	1,289,756	1903	2,712,186
1891	1,206,918	1904	2,389,557
1892	1,594,205	1905	2,791,757

		Duty.	
1906	Tin crystals	Free.	$ 2,634
	Tin in blocks, pigs and bars	"	1,171,569
	Tin plates and sheets	"	1,869,000
	Tin foil	"	65,307
	Tinware, plain, japanned, or lithographed, and all manufactures of tin, N.E.S.	25 %	228,438
	Total		3,336,948

NON-METALLIC.

Abrasive Materials.

The abrasives produced in Canada comprise corundum, the various sandstone abrasives, such as grindstones, pulpstones, whetstones, etc., and tripolite or infusorial earth.

CORUNDUM.

The total shipments of grain corundum in 1906 from mills in Canada were 2,274 tons, valued at $204,973, f. o. b. at railway shipping points. Compared with the shipments in 1905 there is an increase of 630 tons, or over 38 per cent.

Detailed statistics of output and sales for 1906 were as follows:—

Rock treated	45,719 tons.
Grain corundum graded	5,828,905 pounds.
Shipments:—	
Grain corundum sold in Canada	323,103 pounds.
Grain corundum sold in other countries	4,225,073 "
Total sales	4,548,176

Two companies were mining corundum rock and operating mills during the year. The Canada Corundum Company, Ltd., Toronto, the largest operator, worked the Craig mine at Craigmont, Renfrew county, and the Ashland Emery and Corundum Company operated their mine and mill at Burgess Mines, in the same district. Both companies worked throughout the year, employing about 232 men and paying in wages $160,354.

Statistics of shipments since 1900 are as follows:—

		Quantity.	Value.
1900 grain corundum		3 tons.	$ 300
1901 "		387 "	46,415
1902 "		768 "	84,465
1903 "	703	970 "	80,180
corundum ore	267		
1904 grain corundum		993 "	109,545
1905 "		1644 "	149,153
1906 "		2274 "	204,973

Statistics since 1900 showing the quantities of ore treated, the corundum produced, and the sales or shipments, are given in the following table:—

TABLE 1.

ABRASIVE MATERIALS.

PRODUCTION OF CORUNDUM ORE AND CORUNDUM.

Calendar Year.	Corundum-bearing rock treated.	Grain Corundum Graded.	Grain Corundum sold in Canada.	Grain Corundum Exported.	Total of Grain Corundum
	Tons.	Tons.	Tons.	Tons.	Tons.
1900	....	60	....	....	3
1901	4,134	434	85	302	387
1902	7,996	805	106	662	768
1903	(a) 8,877	839	85	618	703
1904	28,187	1,654	116	877	993
1905	23,570	1,680	140	1,504	1,644
1906	45,719	2,914	162	2,112	2,274

(*a*) In addition to this amount which was milled in Canada, 267 tons of ore were mined and shipped to the United States for treatment there.

GRINDSTONES, PULPSTONES, ETC.

The production of grindstones has been carried on for many years in the Province of Nova Scotia. The output to-day is practically the same as it was about 20 years ago, there having been comparatively little variation from year to year. The total production, including wood-pulpstones, etc., in 1906, was 5,363 tons, valued at $59,814.

These abrasives are quarried from the Millstone-grit of the Carboniferous formation, which occupies a large portion of the surface of the eastern half of the Province of New Brunswick, and the northern and north-western parts of Nova Scotia.

The grindstones are all shipped in a finished condition, and are worth from $10 to $12 per ton. About 20 pulpstones were made in 1906, which found a market in Canadian and United States pulp mills. Scythe or whetstones are manufactured by one firm. These are put up in one-quarter gross boxes, thirty pounds to the box, and are worth about $50 per ton; about 300 gross were made in 1906. At some of the quarries there is a considerable production of foundation and building stone, besides rough stone for breakwater and harbour works.

Statistics of the production by provinces since 1886 are given in table 2 following:—

TABLE 2.

ABRASIVE MATERIALS.

ANNUAL PRODUCTION OF GRINDSTONES.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.		Average Value per ton.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1886	1,765	$24,050	2,255	$22,495	4,020	$46,545	$11 58
1887	1,710	25,020	3,582	38,988	5,292	64,008	12 10
1888	1,971	20,400	3,793	30,729	5,764	51,129	8 87
1889	712	7,128	2,692	23,735	3,404	30,863	9 07
1890	850	8,536	4,034	33,804	4,884	42,340	8 67
1891	1,980	19,800	2,499	22,787	4,479	42,587	9 51
1892	2,462	27,610	2,821	23,577	5,283	51,187	9 69
1893	2,112	21,000	2,488	17,379	4,600	38,379	8 34
1894	2,128	16,000	1,629	16,717	3,757	32,717	8 71
1895	1,400	14,000	2,075	17,932	3,475	31,932	9 19
1896	1,450	14,500	2,263	18,810	3,713	33,310	8 97
1897	1,407	17,500	3,165	24,840	4,572	42,340	9 26
1898	1,422	12,350	3,513	32,425	4,935	44,775	9 07
1899	1,378	10,300	3,133	32,965	4,511	43,265	9 59
1900	1,411	12,600	4,128	40,850	5,539	53,450	9 65
1901	358	3,200	4,223	42,490	4,581	45,690	9 97
1902	1,074	8,118	3,559	36,000	4,633	44,118	9 52
1903	1,337	9,562	4,201	38,740	5,538	48,302	8 72
1904	1,029	7,332	3,620	35,450	4,649	42,782	9 20
1905	1,020	10,200	4,520	52,175	5,540	62,375	11 25
1906	1,023	9,680	4,340	50,134	5,363	59,814	11 15

The imports of grindstones into Canada, principally into the Provinces of Ontario and Quebec, reached a total in 1906 of $59,627, made up of grindstone not mounted and not less than three feet in diameter to the value of $48,683, and other grindstones to the value of $10,944.

Statistics of the exports of grindstones and of the imports of grindstones, burrstones, emery and pumice stone are shown in tables 3, 4, 5, 6, and 7 following.

TABLE 3.

ABRASIVE MATERIALS.

EXPORTS OF GRINDSTONES.

Calendar Year.	Value.
1884	$28,186
1885	22,606
1886	24,185
1887	28,769
1888	28,176
1889	29,982
1890	18,564
1891	28,433
1892	23,567
1893	21,672
1894	12,579
1895	16,723
1896	19,139
1897	18,807
1898*	25,588
1899*	23,288
1900*	42,128
1901*	29,130
1902*	24,489
1903*	27,659
1904*	35,612
1905*	24,868
1906*	31,978

* Including stone for the manufacture of grindstones.

TABLE 4.
ABRASIVE MATERIAL.
IMPORTS OF GRINDSTONE.

Fiscal Year.	Duty.	Tons.	Value.
1880	....	1,044	$11,714
1881	....	1,359	16,895
1882	....	2,098	30,654
1883	....	2,108	31,456
1884	....	2,074	30,471
1885	....	1,148	16,065
1886	....	964	12,803
1887	....	1,309	14,815
1888	....	1,721	18,263
1889	....	2,116	25,564
1890	....	1,567	20,569
1891	....	1,381	16,991
1892	....	1,484	19,761
1893	....	1,682	20,987
1894	....	1,918	24,426
1895	....	1,770	22,834
1896	....	1,862	26,561
1897	....	1,521	25,547
1898	....	....	22,217
1899	....	....	27,476
1900	....	....	34,382
1901	....	....	39,068
1902	....	....	40,838
1903	....	....	53,388
1904	....	....	46,039
1905	....	....	49,747
1906 { Grindstones not mounted and not less than 36 inches in diameter....	15 p. c.	....	48,683
1906 { Grindstones N.E.S.....	25 p. c.	....	10,944
			59,627

TABLE 5.
ABRASIVE MATERIAL.
IMPORTS OF BURRSTONES.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$12,049	1893	$ 3,552
1881	6,337	1894	3,029
1882	15,143	1895	2,172
1883	13,242	1896	2,049
1884	5,365	1897	1,827
1885	4,517	1898	1,813
1886	4,062	1899	1,759
1887	3,545	1900	1,546
1888	4,753	1901	5,762
1889	5,465	1902	2,559
1890	2,506	1903	586
1891	2,089	1904	35
1892	1,464	1905	2,607
		1906*	2,661

* Burrstones in blocks, rough or unmanufactured, not bound up or prepared by binding into mill-stones. Duty free.

TABLE 6.

ABRASIVE MATERIALS.

IMPORTS OF EMERY.

Fiscal Year.	Emery. *a.*	Mfrs. of Emery. *b.*
1885	$ 5,066	$ 4,920
1886	11,877	5,832
1887	12,023	4,598
1888	15,674	4,001
1889	13,565	3,948
1890	16,922	5,313
1891	16,179	6,665
1892	17,782	6,492
1893	17,762	5,606
1894	14,433	2,223
1895	14,569	7,775
1896	16,287	11,913
1897	16,318	11,231
1898	17,661	15,478
1899	21,454	22,343
1900	19,312	25,615
1901	16,311	22,190
1902	14,476	23,892
1903	18,058	22,177
1904	21,626	29,273
1905	21,980	33,250
1906	21,781	42,080

a Emery in bulk, crushed or ground. Duty free.
b Emery wheels and manufactures of emery. Duty 25 p.c.

TABLE 7.

ABRASIVE MATERIAL.

IMPORTS OF PUMICE STONE.

Fiscal Year.	Value.
1885	$ 9,384
1886	2,777
1887	3,594
1888	2,890
1889	3,232
1890	3,003
1891	3,696
1892	3,282
1893	3,798
1894	4,160
1895	3,609
1896	3,721
1897	2,903
1898	3,829
1899	5,973
1900	5,604
1901	5,516
1902	7,254
1903	6,152
1904	6,537
1905	8,447
*1906	9,053

* Pumice and pumice stone, ground or unground. Duty free.

TRIPOLITE.

There were practically no shipments of tripolite from Canadian deposits during 1906. Statistics of production of past years are shown in the following table.

Table 8.

Abrasive Material.

Production of tripolite.

Calendar Year..	Tons.	Value.
		$
1896	644	9,960
1897	15	150
1898	1,017	16,660
1899	1,000	15,000
1900	336	1,950
1901	850	15,300
1902	1,052	16,470
1903	835	16,700
1904	320	6,400
1905	200	3,600
1906	nil	nil

ASBESTOS.

Returns from about twelve producing asbestos mines in 1906 showed a total production of asbestos and asbestic of 82,185 tons, valued at $2,060, 143, made up as follows :—

——	Tons.	Value.	Average value per ton.
Crude Asbestos	3,841	$ 635,345	$16.54
Mill Stock	56,920	1,401,083	24.61
Total Asbestos	60,761	2,036,428	33.52
Asbestic, etc.	21,424	23,715	1.10
Total	82,185	2,060,143	25.06

Compared with 1905 an increase in total tonnage is shown of 13,922 or 20·3 per cent, while the increase in value was $556,884 or 37 per-cent. Statistics of production for several years past, as given in table 1, show the industry to be rapidly growing in volume.

Prices have been well maintained. In 1906 the range was about as follows :—

Crude No. 1	from $175 to $250 per ton.
Crude No. 2.	" 110 to 150 "
Mill Stock	" 8 to 80 "
Asbestic	" 1 to 5 "
Asbestic Sand	50 cents per ton.

The crude stock and fibre are exported chiefly to the United States; but also to Great Britain, Germany and other countries. The exports during the calendar year 1906 totaled 59,854 tons valued at $1,689,257, as follows :—

	Tons.	Value.
To Great Britain	9,435	$ 318,313
To United States	39,767	1,058,513
To Germany	3,654	82,117
To other countries	6,998	230,314
Total	59,854	$1689,257

The imports of asbestos during the fiscal year were valued at $137,974, as compared with $116,836 in 1905.

During the year the Shawenegan Water Power Company built a power line to Thetford, and is now supplying electric power to the mines. Another important development during the year is the beginning of underground work by the Bell Asbestos Mines, and the American Asbestos Company. Hitherto all the working has been by open quarry.

Statistics of production, exports, and imports are given in the following tables :—

TABLE 1.

ASBESTOS.

PRODUCTION.—1896 to 1906.

——	Tons.	Value.	Average Value per ton.
1896—Asbestos	10,892	$ 423,066	$ 38.84
Asbestic	1,358	6,790	5.00
	12,250	$ 429,856	$ 35.09
1897—Asbestos	13,202	$ 399,528	$ 30.26
Asbestic	17,240	45,840	2.66
	30,442	$ 445,368	$ 14.63
1898—Asbestos	16,124	$ 475,131	$ 29.46
Asbestic	7,661	16,066	2.10
	23,785	$ 491,197	$ 20.65
1899—Asbestos	17,790	$ 468,635	$ 26.34
Asbestic	7,746	17,214	2.22
	25,536	$ 485,849	$ 19.03
1900—Asbestos	21,621	$ 729,886	$ 33.76
Asbestic	7,520	18,545	2.46
	29,141	$ 748,431	$ 25.68
1901—Asbestos	32,892	$ 1,248,645	$ 37.96
Asbestic	7,325	11,114	1.52
	40,217	$ 1,259,759	$ 31.32
1902—Asbestos	30,219	$ 1,126,688	$ 37.28
Asbestic	10,197	21,631	2.12
	40,416	$ 1,148,319	$ 28.41
1903—Asbestos	31,129	$ 915,888	$ 29.42
Asbestic	10,548	13,869	1.31
	41,677	929,757	$ 22.31
1904—Asbestos	35,611	$1,213,502	$ 34.07
Asbestic	12,854	12,850	1.00
	48,465	$1,226,352	$ 25.30
1905—Asbestos	50,669	$1,486,359	$ 29.33
Asbestic	17,594	16,900	.96
	68,263	$1.503,259	$ 22.02
1906—Asbestos	60,761	$2,036,428	33.52
Asbestic	21,424	23,715	1.11
	82,185	2,060,143	25.07

TABLE 2.

ASBESTOS.

PRODUCTION, ETC.—1880 TO 1895.

Calendar Year.	Production.			Exports Average value per ton.
	Tons 2,000 Pounds.	Value.	Average Value per ton.	
		$	$ c.	$ c.
1880	380	24,700	65.00	Exports taken as production.
1881	540	35,100	65.00	
1882	810	52,650	65.00	
1883	955	68,750	71.98	
1884	1,141	75,097	65 80	
1885	2,440	142,441	58.37	
1886	3,458	206,251	59.64	
1887	4,619	226,976	49.14	63.25
1888	4,404	255,007	57.90	70.56
1889	6,113	426,554	69.77	64.44
1890	9,860	1,260,240	127.81	75.52
1891	9,279	999,878	107.75	70.07
1892	6,082	390,462	64.19	69.35
1893	6,331	310,156	49.02	57.24
1894	7,630	420,825	55.15	59.82
1895	8,756	368,175	42.05	56.66

TABLE 3.

ASBESTOS.

EXPORTS.

Calendar Year.	Tons.	Value.	Average value per ton.
1892	5,380	$373,103	$69.35
1893	5,917	338,707	57.24
1894	7,987	477,837	59.82
1895	7,442	421,690	56.66
1896	11,842	567,967	47.96
1897	15,570	473,274	30.40
1898	15,346	494,012	32.19
1899	17,883	473,148	26.46
1900	16,993	693,105	39.61
1901	32,269	1,069,918	33.16
1902	31,074	995,071	32.02
1903	31,780	891,033	28.04
1904	37,272	1,160,887	31.14
1905	47,031	1,386,115	29.47
1906	59,854	1,689,257	28.22

TABLE 4.

ASBESTOS.

IMPORTS.

Fiscal Year.	Value.	Fiscal Year.	Value.
1885	$ 674	1896	$ 23,900
1886	6,831	1897	19,032
1887	7,836	1898	26,389
1888	8,793	1899	32,607
1889	9,943	1900	43,455
1890	13,250	1901	50,829
1891	13,298	1902	52,464
1892	14,090	1903	75,465
1893	19,181	1904	83,827
1894	20,021	1905	116,836
1895	26,094	*1906	137,974

*Asbestos in any form other than crude, and all manufactures of. Duty 25 p.c.

CHROMITE.

Within the past few years considerable improvements have been made in the methods of mining and treatment of the chromite ores of the Eastern townships, Province of Quebec. The total shipments in 1906 were 9,035 tons valued at $91,859, as compared with 8,575 tons valued at $93,301 in 1905; and shipments of 6,074 tons and 3,509 tons in 1904 and 1903 respectively.

The shipments in 1906 consisted of 4,060 tons of low grade product valued at $34,375, or an average of $8.46 per ton, and of 4,975 tons of high grade, chiefly concentrates, valued at $57,484 or an average of $11.55 per ton.

The prices realized were somewhat lower than those obtained in 1905.

The Canadian product is shipped to the United States and Europe, and is used in Canada in the manufacture of ferro-chrome at Buckingham, Que.

One of the largest producers reports that the unusual demand for iron and steel products has made a very satisfactory market for chrome ores of low grades suitable for furnace linings. The installation cf modern mining and milling methods has enabled miners at Black Lake to meet the competition of New Caledonian and Turkish chrome ores in a fairly successful manner. A market in Canada is also opening up at Sydney, N.S., for the open-hearth furnaces there, and also at Buckingham where the Electric Reduction Company has again started the manufacture of ferro chrome.

The methods of mining and concentrating the ore were described in the last report of this Section as follows :—

"The ore is sorted as it comes from the pit, and all running over 40 p.c. sesquioxide of chromium is graded crude No. 1 (over 47 p.c.) and No. 2 (between 40 p c. and 47 p.c). The waste or ore running less than 40 p.c. Cr_2O_3 is sent to the mills for concentration. Here it is crushed in jaw crushers and under stamps, and concentrated in Wilfley tables. Two grades of concentrates are produced and are finding a ready market chiefly in the United States. The high grade concentrates running 50 to 54 p.c. C_2 O_3 are competing successfully with the high grade ores of New Caledonia."

The Black Lake Chrome and Asbestos Company operated throughout the year with a force of 85 men. This Company has a 30 stamp mill for concentrating its low grade ore, a tramway operated by cable connecting the shafts with the mill, and an air compressor at the pit, the whole plant being operated by electric power obtained from the St. Francis Hydraulic Company. This Company has also obtained control of the properties of the Montreal Chrome Iron Company.

The Canadian Chrome Co., Ltd., has completed the installations of concentrating works consisting of a 20 stamp mill and five Wilfley tables. Other companies owning properties in the district confined their attention to prospecting and development work.

The following list of companies comprises those chiefly interested in the Canadian chrome mining industry:—

The Black Lake Chrome and Asbestos Company, 86 Notre Dame St., Montreal, Que.

The Coleraine Chrome Co., W. H. Lambly, Inverness, Que.

The Canadian Chrome Co., Ltd., Thetford Mines, Que.

The American Chrome Co., Black Lake, Que.

The Star Chrome Co., 570 St. Denis St., Montreal, Que.

King Bros., Thetford Mines, Que.

Uses and Markets : The principal uses of chrome ore are for the manufacture of chromium salts and ferro-chrome alloys, and as a lining in open-hearth steel furnaces.

Prices in New York in 1906 ranged from $17.25 to $19.75 per long ton for 50 p.c. ore. The chief consumers in the United States are, as published in the Mineral Industry, New York—

The Kalion Chemical Company, Philadelphia, Pa.

The Baltimore Chrome Works, Baltimore, Md.

The Harbison-Walker Refractories Company, Pittsburg, Pa.

TABLE 1.

CHROMITE.

ANNUAL PRODUCTION.

Calendar Year.	Tons. 2,000 lbs.	Average price per ton.	Value.
		$ cts	$
1886	* 60	15 75	945
1887	38	15 00	570
1888 to 1893	Pas d. pro.	....	....
1894	1,000	20 00	20,000
1895	3,177	13 00	41,300
1896	2,342	11 53	27,004
1897	2,637	12 31	32,474
1898	*2,021	12 00	24,252
1899	2,010	10 86	21,842
1900	2,335	11 56	27,000
1901	1,274	13 14	16,744
1902	900	14 44	13,000
1903	3,509	14 57	51,129
1904	6,074	11 05	67,145
1905	8,575	10 88	93,301
1906	9,035	10 17	91,859

* Railway shipments.

TABLE 2.

CHROMITE.

EXPORTS.

Calendar Year.	Tons.	Value.
1895	2,908	$ 42,236
1896	2,466	31,411
1897	2,106	26,254
1898	1,683	20,783
1899	1,509	19,876
1900	368	8,259
1901	2,259	25,444
1902	740	7,535
1903	1,013	20,524
1904	3,338	60,336
1905	5,042	45,072
1906	891	10,188

COAL.

From the point of view of value, coal is the most important of Canada's mineral productions, constituting as it does over 24 p. c. of the total mineral output.

The total sales and shipments of coal in 1906 from mines throughout Canada were 9,762,601 short tons (8,716,608 long tons) valued at $19,732,019, compared with 8,667,948 short tons (7,739,239 long tons), valued at $17,520,263 in 1905. The increase of production was, therefore, 1,094,653 short tons or 12·6 p. c. and in value $2,211,756 or 12·6 p. c., the average price per ton being practically the same in both years.

Only one anthracite mine is worked in Canada, the Bankhead Mines Ltd., at Banff, Alberta, and with this exception all of the coal mined is of the bituminous or lignite variety. Detailed statistics of production are given in tables 1, 2, and 3 following :—

Table 1.

Coal.

Production by Provinces, 1904, 1905 and 1906.

Province.	1904.		1905.		1906.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$
Nova Scotia ...	5,596,241	9,993,288	5,646,583	10,083,184	6,220,505	11,108,044
British Columbia	1,862,625	4,989,174	1,945,452	5,211,030	2,146,262	5,748,915
North West Territories including Yukon..	786,617	1,591,545	1,046,513	2,167,249	1,361,758	2,806,908
New Brunswick	9,112	18,224	29,400	58,800	34,076	68,152
Total.......	8,254,595	16,592,231	8,667,948	17,520,263	9,762,601	19,732,019

TABLE 2.

PRODUCTION.—COMPARISON OF 1905 AND 1906.

Province	Increase or Decrease.			
	Tons.	Per Cent.	Value.	Per Cent.
			$	
Nova Scotia	i 573,922	10·16	i 1,024,860	10·16
British Columbia	i 200,810	10·32	i 537,885	10·32
North West Territories and Yukon	i 315,245	30·12	i 639,659	29·51
New Brunswick	i 4,676	15·90	i 9,352	15·90
Dominion	i 1,094,653	12·63	i 2,211,756	12·62

N.B. *i* Increase. *d* Decrease.

TABLE 3.

COAL.

ANNUAL PRODUCTION SHOWING THE INCREASE OR DECREASE EACH YEAR.

Calendar Year.	Tons.	Value.	Average Value per Ton.	Increase (*i*) or Decrease (*d*) in Tonnage.	Incr. (*i*) or Decr. (*d*) per cent.
1886	2,116,653	$3,739,840	$1 77	....	....
1887	2,429,330	4,388,206	1 81	i 312,677	i 14·8
1888	2,602,552	4,674,140	1 80	i 173,222	i 7·1
1889	2,658,303	4,894,287	1 84	i 55,751	i 2·1
1890	3,084,682	5,676,247	1 84	i 426,379	i 16·0
1891	3,577,749	7,019,425	1 96	i 493,067	i 16·0
1892	3,287,745	6,363,757	1 94	d 290,004	d 8·1
1893	3,783,499	7,359,080	1 95	i 495,754	i 15·1
1894	3,847,070	7,429,468	1 93	i 63,571	i 1·7
1895	3,478,344	6,739,153	1 94	d 368,726	d 9·6
1896	3,745,716	7,226,462	1 93	i 267,372	i 7·7
1897	3,786,107	7,303,597	1 93	i 40,391	i 1·1
1898	4,173,108	8,224,288	1 97	i 387,001	i 10·2
1899	4,925,051	10,283,497	2 09	i 751,943	i 18·0
1900	5,777,319	13,742,178	2 38	i 852,268	i 17 3
1901	6,486,325	12,699,243	1 96	i 709,006	i 12.3
1902	7,466,681	15,210,877	2 04	i 780,356	i 15·1
1903	7,960,364	15,9[illegible]2,833	2 00	i 493,683	i 6·6
1904	8,254,595	16,592,231	2 01	i 294,231	i 3.7
1905	8,667,948	17,520,263	2 02	i 413,353	i 5 0
1906	9,762,601	19,732,019	2 02	i 1,094,653	i 12·6

Of the total production in 1906 Nova Scotia and New Brunswick contributed about 64 p. c.; Saskatchewan, Alberta and Yukon 13·9 p. c., and British Columbia 21·9 p. c. The following short table illustrates the relative importance of the various provinces as producers of coal at various periods since 1874 :—

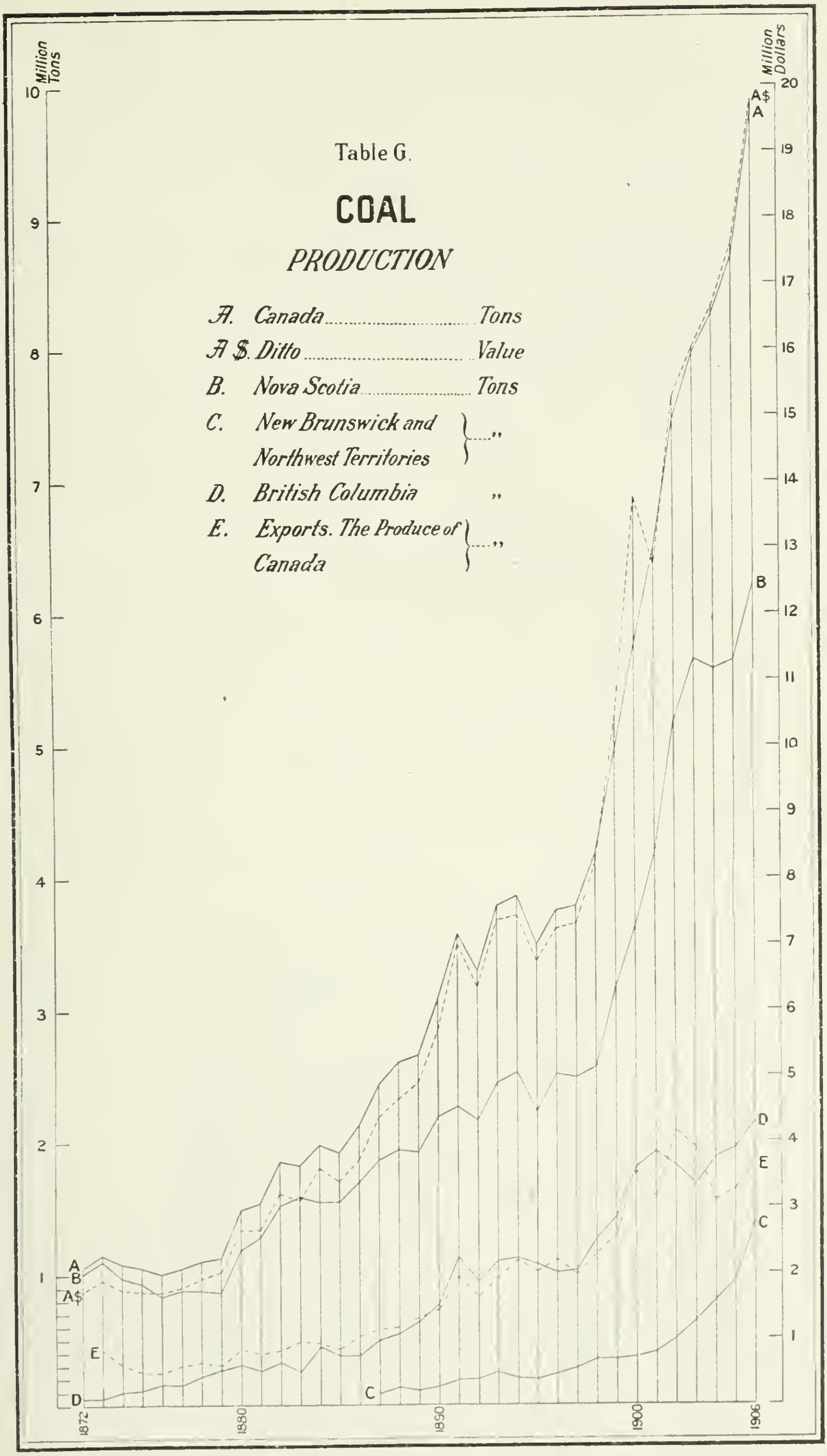


Table G.
COAL
PRODUCTION
A. Canada .... Tons
A $. Ditto .... Value
B. Nova Scotia .... Tons
C. New Brunswick and Northwest Territories ....,,
D. British Columbia ,,
E. Exports. The Produce of Canada ....,,
Million Tons
Million Dollars
1872
1880
1890
1900
1906

Province.	1874	1880	1890	1898	1899	1900	1901	1902	1903	1904	1905	1906
	p. c.	p. c.	p.c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
Nova Scotia, New Brunswick	91	79	71	61·6	64·2	62·9	64·4	69·4	71·3	68·0	65·5	64·07
Saskatchewan, Alberta and Yukon..	8	20	4	8·3	6·8	6·1	6·0	6·4	7·7	9·5	12·1	13·95
B. Columbia.	...	...	25	30·3	29·0	31·0	29·6	24·2	21·0	22·5	22·4	21·98

In each province or district, as shown in table 2, a larger production was obtained in 1906 than in 1905, the largest proportional increase being in Alberta and Saskatchewan, which had an increased output of over 30 p. c. In Nova Scotia the increase was a little over 10 p. c.; in New Brunswick, where the total production was only 34,076 tons, the increase was nearly 16 p. c.; while in British Columbia an increase of over 10 p. c. is shown.

The total quantity of Canadian coal exported in 1906 was 1,835,041 tons, nearly 200,000 tons more than was exported in 1905. This coal is exported from both the eastern and western provinces, and chiefly to the adjacent states of the United States.

The imports of coal into Canada during the fiscal year ending June 30, comprising bituminous, anthracite and coal dust, reached a total of 7,443,664 tons, which is imported chiefly from the states of Pennsylvania and Ohio to the Provinces of Ontario and Quebec.

Statistics of exports and imports since 1880, shown in tables 4 to 8, have been compiled from the Trade and Navigation Reports published by the Department of Customs.

TABLE 4.

COAL.

EXPORTS.

Calendar Year.	Produce of Canada.	Not the Produce of Canada.	Calendar Year.	Produce of Canada.	Not the Produce of Canada.
	Tons.	Tons.		Tons.	Tons.
1873.........	420.683	5,403	1890.........	724,486	82,534
1874.........	310,988	12,859	1891.........	971,259	77,827
1875.........	250,348	14,026	1892.........	823,733	93,988
1876.........	248,638	4,995	1893.........	960,312	102,827
1877.........	301,317	4,829	1894.........	1,103,694	89,786
1878.........	327,959	5,468	1895.........	1,011,235	96,836
1879.........	306,648	8,468	1896.........	1,106,661	116,774
1880.........	432,188	14,217	1897.........	986,130	101,848
1881.........	395,382	14,245	1898.........	1,150,029	99,189
1882.........	412,682	37,576	1899.........	1,293,169	101,004
1883.........	486,811	44,388	1900.........	1,787,777	62,776
1884.........	474,405	62,665	1901.........	1,573,661	53,894
1885.........	427,937	71,003	1902.........	2,090,268	23,453
1886....	520,703	78,443	1903.........	1,954,629	27,138
1887.........	580,965	89.098	1904.........	1,557,412	27,308
1888.........	588,627	84,316	1905.........	1,635,287	86,792
1889.........	665,315	89,294	1906.........	1,835,041	44,758

TABLE 5.

COAL.

EXPORTS.—NOVA SCOTIA AND BRITISH COLUMBIA.

Calendar Year.	Nova Scotia.		*British Columbia.	
	Tons.	Value.	Tons.	Value.
1874	252,124	$647,539	51,001	$ 278,180
1875	179,626	404,351	65,842	356,018
1876	126,520	263,543	116,910	627,754
1877	173,389	352,453	118,252	590,263
1878	154,114	293,795	165,734	698,870
1879	113,742	203,407	186,094	608,845
1880	199,552	344,148	219,878	775,008
1881	193,081	311,721	187,791	622,965
1882	216,954	390,121	179,552	628,437
1883	192,795	336,088	271,214	946,271
1884	222,709	430,330	245,478	901,440
1885	176,287	349,650	250,191	1,000,764
1886	240,459	441,693	274,466	960,649
1887	207,941	390,738	356,657	1,262,552
1888	165,863	330,115	405,071	1,605,650
1889	186,608	396,830	470,683	1,918,263
1890	202,387	426,070	508,882	1,977,191
1891	194,867	417,816	767,734	2,958,695
1892	181,547	407,980	599,716	2,317,734
1893	203,198	470,695	708,228	2,693,747
1894	310,277	633,398	770,439	2,855,216
1895	241,091	534,479	728,283	2,692,562
1896	380,149	787,270	679,799	2,507,752
1897	307,128	642,754	630,341	2,221,737
1898	309,158	629,363	813,843	2,948,428
1899†	459,260	827,941	781,809	2,947,369

* See foot-note, table 16. † Since 1899, exports by provinces have not been published in Trade and Navigation Report.

TABLE 6.

COAL.

IMPORTS OF BITUMINOUS COAL.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761	1894	1,359,509	$3,315,094
1881	587,024	1,741,568	1895	1,444,928	3,321,387
1882	636,374	1,992,081	1896	1,538,489	3,299,025
1883	911,629	2,996,198	1897	1,543,476	3,254,217
1884	1,118,615	3,613,470	1898	1,684,024	3,179,595
1885	1,011,875	3,197,539	1899	2,171,358	3,691,946
1886	930,949	2,591,554	1900	2,439,764	4,310,964
1887	1,149,792	3,126,225	1901	2,516,392	4,956,025
1888	1,231,234	3,451,661	1902	3,047,392	5,712,058
1889	1,248,540	3,255,171	1903	3,511,412	7,776,717
1890	1,409,282	3,528,959	1904	4,053,900	9,108,208
1891	1,598,855	4,060,896	1905	4,176,274	8,002,896
1892	1,615,220	4,099,221	1906*	4,495,550	8,360,348
1893	1,603,154	3,967,764			

* Duty, 53 cts. per ton.

TABLE 7.

COAL.

IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960	1894	1,530,522	$6,354,040
1881	572,092	2,325,937	1895	1,404,342	5,350,627
1882	638,273	2,666,356	1896	1,574,355	5,667,096
1883	754,891	3,344,936	1897	1,457,295	5,695,168
1884	868,000	3,831,283	1898	1,460,701	5,874,685
1885	910,324	3,909,844	1899	1,745,460	6,490,509
1886	995,425	4,028,050	1900	1,654,401	6,602,912
1887	1,100,165	4,423,062	1901	1,933,283	7,923,950
1888	†2,138,627	5,291,875	1902	1,652,451	7,021,939
1889	1,291,705	5,199,481	1903	1,456,713	7,028,664
1890	1,201,335	4,595,727	1904	2.275,018	10,461,223
1891	1,399,067	5,224,452	1905*	2,604,137	12,093,371
1892	1,479,106	5,640,346	1906	2,200,863	10,304,308
1893	1,500,550	6,355,285			

* Coal anthracite, and anthracite coal dust. Duty free.

† In Table 7, Imports of Anthracite Coal, a very considerable increase will be noticed in 1888 over 1887, an increase of over ninety-four per cent, the falling off again in 1889 being quite as remarkable. The average values per ton for the three years 1887, 1888 and 1889, were $4.02, $2.47 and $4.03 respectively. Although a duty of fifty cents per ton on anthracite coal was removed May 13, 1887, it is hardly thought this would account for the changes indicated, and unless some error may possibly have crept into the Trade and Navigation Report, no explanation is available.

TABLE 8.

COAL.

IMPORTS OF COAL DUST.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
1880	3,565	$ 8,877	1894	117,573	$ 49,510
1881	337	666	1895	181,318	52,221
1882	471	900	1896	210,386	53,742
1883	8,154	10,082	1897	225,562	59,609
1884	12,782	14,600	1898	229,445	45,556
1885	20,185	20,412	1899	276,547	44,717
1886	36,230	36,996	1900	330,174	98,349
1887	31,401	33,178	1901	414,432	275,559
1888	28,808	34,730	1902	489,548	264,550
1889	39,980	47,139	1903	550,883	420,317
1890	53,104	29,818	1904	608,041	544,123
1891	60,127	36,130	1905	650,261	343,456
1892	82,091	39,840	1906*	747,251	489,180
1893	109,585	44,474			

* Duty, 20 p. c., not over 13c. per ton.

With statistics of production, exports and imports of coal available, an estimate of the Canadian consumption can very readly be made, but as the statistics of imports do not cover the same period of 12 months as the other figures the results can only be taken as approximate.

Following is an estimate of the consumption of coal in 1906, while table 9 shows the statistics of consumption annually since 1886.

Consumption of Coal in Canada, 1906.

——	Tons.	Tons.
Production, Table 3	9,762,601	
Exports of Canada, Table 4	1,835,041	
Home Consumption of Canadian Coal		7,927,560
Imports, Tables 6, 7, 8	7,443,664	
Exports, not Produce	44,758	
Canadian Consumption of Imported Coal		7,398,906
Total Consumption of Coal in Canada, 1906		15,326,466

It will be observed that approximately one-half of the coal consumed is imported, and one-half from Canadian mines. Taking the exports of Canadian coal into consideration, however, it would appear that the total output would supply about 60 per cent of the Dominion's requirements.

Table 9.

Coal.

Consumption of Coal in Canada.

Calendar Year.	Canadian.	Imported.	Total.	Percentage Canadian.	Percentage Imported.	Consumption per capita.
	Tons.	Tons.	Tons.			Tons.
1886	1,595,950	1,884,161	3,480,111	45·9	54·1	·758
1887	1,848,365	2,192,260	4,040,625	45·7	54·3	·871
1888	2,013,925	3,314,353	5,328,278	37·8	62·2	1·137
1889	1,992,988	2,490,931	4,483,919	44·4	55·6	·946
1890	2,360,196	2,581,187	4,941 383	47·8	52·2	1·031
1891	2,606,490	2,980,222	5,586,712	46·7	53·3	1·153
1892	2,464,012	3,082,429	5,546,441	44·4	55·6	1·133
1893	2,823,187	3,110,462	5,933,649	47·6	52·4	1·198
1894	2,743,376	2,917,818	5,661,194	48·5	51·5	1·130
1895	2,467,109	2,933,752	5,400,861	45 7	54·3	1·066
1896	2,639,055	3,206,456	5,845,511	45·1	54·9	1·140
1897	2,799,977	3,124,485	5,924,462	47·3	52·7	1·143
1898	3,023,079	3,274,981	6,298,060	48·0	52·0	1·200
1899	3,631,882	4,092,361	7,724,243	47·0	53·0	1·454
1900	3,989,542	4,361,563	8,351,105	47·8	52·2	1·561
1901	4,912,664	4,810,213	9,722,877	50·5	49·5	1·810
1902	5,376,413	5,165,938	10,542,351	51·0	49·0	1·927
1903	6,005,735	5,491,870	11,507,605	52·2	47·8	2·055
1904	6,697,183	6,909,651	13,606,834	49·2	50·8	2·346
1905	7,032,661	7,343,880	14,376,541	48·9	51·1	2·396
1906	7,927,560	7,398,906	15,326,466	57·7	48·3	2·425

Below are given some of the main features of the year's development of the coal mining industry by provinces :—

Nova Scotia :—Detailed statistics of coal production in Nova Scotia are shown in tables 10, 11, 12 and 13. Table 10 shows the annual production since 1872 in both long and short tons ; table 11 shows the quantities of coal raised and sold by counties during 1906 ; table 12 the output by collieries during the same year, and table 13 the distribution of coal sold.

The production in 1906 was greater than in 1905 by about 10 per cent, and over 36 per cent of the output was from the mines of the Dominion Coal Co. at Glace Bay. The coal finds a market in the adjoining provinces and in the United States, as well as locally. As shown in table 13, about 37 per cent is sold within the Province, over 34 per cent went to the Province of Quebec, while a little over 14 per cent was exported to the United States, chiefly to Everett, Mass., for use in the manufacture of gas and coke.

About 8 per cent was sold in New Brunswick, and nearly 3 per cent in Newfoundland.

TABLE 10.

COAL.

NOVA SCOTIA :—OUTPUT, SALES, COLLIERY CONSUMPTION, AND PRODUCTION.

Calendar Year.	Output, Tons, 2,240 lbs.	Sales, Tons, 2,240 lbs.	Colliery Consumption, Tons, 2,240 lbs.	Production* Tons 2,240 lbs.	Output, Tons, 2,000 lbs.	Sales. Tons, 2,000 lbs.	Colliery Consumption, Tons. 2,000 lbs.	Production* Tons, 2,000 lbs.	Price per ton. 2,240 lbs.	Value of production.
1872	880,950	785,914	110,341	896,255	986,664	880,224	123,582	1,003,806	$1 75	$1,568,446
1873	1,051,467	881,106	108,398	989,504	1,177,643	986,839	121,406	1,108,245	1 75	1,731,632
1874	872,720	749,127	119,582	868,709	977,446	839,022	133,932	972,954	1 75	1,520,240
1875	781,165	706,795	124,110	830,905	874,905	791,610	139,003	930,613	1 75	1,454,084
1876	709,646	634,207	113,788	747,995	794,804	710,312	127,443	837,755	1 75	1,308,991
1877	757,496	687,065	98,841	785,906	848,396	769,513	110,702	880,215	1 75	1,375,339
1878	770,603	693,511	88,627	782,138	863,075	776,732	99,262	875,994	1 75	1,368,741
1879	788,271	688,624	84,787	773,411	882,863	771,259	94,961	866,220	1 75	1,353,469
1880	1,032,710	954,659	96,831	1,051,490	1,156,635	1,069,218	108,451	1,177,669	1 75	1,840,108
1881	1,124,270	1,035,014	107,888	1,142,902	1,259,183	1,159,216	120,834	1,280,050	1 75	2,000,079
1882	1,365,811	1,250,179	111,381	1,361,560	1,529,708	1,400,200	124,747	1,524,947	1 75	2,382,730
1883	1,422,553	1,297,523	111,949	1,409,472	1,593,259	1,453,226	125,383	1,578,609	1 75	2,466,576
1884	1,389,295	1,261,650	116,769	1,378,419	1,556,011	1,413,048	130,781	1,543,829	1 75	2,412,233
1885	1,352,205	1,254,510	127.624	1,382,134	1,514,470	1,405,051	142,939	1,547,990	1 75	2,418,735
1886	1,502,611	1,373,666	142,421	1,516,087	1,682,924	1,538,506	159,512	1,698,018	1 75	2,653,152
1887	1,670,830	1,519,684	139,777	1,659,461	1,871,330	1,702,046	156,550	1,858,596	1 75	2,904,057
1888	1.776,128	1,576,692	157,443	1,734,135	1,989,263	1,765,895	176,336	1,942,231	1 75	3,034,735
1889	1,756,279	1,555,107	158,131	1,713,238	1,967,032	1,741,720	177,107	1,918,827	1 75	2,998,167
1890	1,984,001	1,786,111	161,240	1,947,351	2,222,081	2,000,444	180,589	2,181,033	1 75	3,407,864
1891	2,044,784	1,849,945	174,983	2,024,928	2,290,158	2,071,938	195,981	2,267,919	1 75	3,543,624
1892	1,942,780	1,752,934	175,092	1,928,026	2,175,913	1,963,286	196,103	2,159,389	1 75	3,374,046
1893	2,223,042	1,977,543	205,425	2,182,968	2,489,807	2,214,848	230,076	2,444,924	1 75	3,820,194
1894	2,250,631	2,060,920	196,206	2,257,126	2,520,707	2,308,231	219,751	2,527,982	1 75	3,949,970
1895	1,999,756	1,793,098	193,639	1,986,737	2,239,727	2,008,270	216,875	2,225,145	1 75	3,476,790
1896	2,292,675	2,046,828	192,975	2,239,803	2,567,796	2,292,447	216,132	2,508,579	1 75	3,919,655
1897	2,340,031	2,044,672	181,716	2,226,388	2,620,835	2,290,032	203,522	2,493,554	1 75	3,896,179
1898	2,262,656	2,121,126	167,428	2,288,554	2,534,175	2,375,661	187,519	2,563,180	1 75	4,004,970
1899	2,865,443	2,633,989	177,460	2,811,449	3,209,296	2,950,067	198,755	3,148,822	2 00	5,622,898
1900	3,298,791	2,998,737	236,563	3,235,300	3,694,646	3,358,585	264,951	3,623,536	2 50	8,088,250
1901	3,821,033	3,411,127	301,434	3,712,561	4,279,557	3,820,462	337,606	4,158,068	1 75	6,496,982
1902	4,725,480	4,229,120	379,198	4,608 318	5,292,538	4,736,614	424,702	5,161,316	2 00	9,216,636
1903	5,215,562	4,565,720	481,903	5,047,623	5,841,429	5,113,607	539,731	5,653,338	2 00	10,095,246
1904	5,131,985	4,551,740	444,904	4,996,644	5,747,823	5,097,949	498,292	5,596,241	2 00	9,993,288
1905	5,197,877	4,613,818	427,774	5,041,592	5,821,622	5,167,476	479,107	5,646,583	2 00	10,083,184
1906	5,844,813	5,093,131	460,891	5,554,022	6,546 191	5,704,307	516,198	6,220,505	2 00	11,108,044

* This production is obtained by adding sales and colliery consumption. For sales previous to 1872, see report of the Department of Mines, Nova Scotia, 1883, page 68.

TABLE 11.

COAL.

NOVA SCOTIA:—COAL TRADE BY COUNTIES, 1906.

Calendar Year.	Cumberland.		Pictou.		Cape Breton.		Other Counties.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.
	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.
1st Quarter	203,286	179,387	184,172	147,067	1,028,587	697,538	32,769	22,179
2nd "	162,721	142,204	201,771	170,647	1,266,300	1,205,178	79,712	60,163
3rd "	151,534	128,862	179,665	159,535	1,311,040	1,366,344	95,006	93,493
4th "	142,193	115,855	203,888	180,061	1,198,480	952,233	105,067	83,561
Total, 1906	659,734	566,308	769,496	657,310	4,804,407	4,221,293	312,554	259,396
" 1905	693,500	595,064	668,454	560,937	4,218,970	3,858,641	210,698	152,834

TABLE 12.

COAL.

NOVA SCOTIA :—OUTPUT BY COLLIERIES DURING CALENDAR YEAR 1906.

Colliery.	Tons, 2,000 lbs.	Colliery.	Tons, 2,000 lbs.
Cumberland County.		*Inverness County.*	
Joggins	57,200	Mabou	24,725
Minudie	37,939	Port Hood	20,829
Scotia	2,128	Inverness Ry. & Coal Co .	261,411
Springhill.............	480,569		
Strathcona..............	26,499	*Cape Breton County.*	
Prospect	8,150		
Maritime...............	47,248	Sydney Coal Co..........	3,775
		Dominion Coal Co.	3,979,075
Pictou County.			
		N. Scotia Steel & Coal Co	770,655
Acadia		Gowrie & Blockhouse Collieries................	50,340
NovaScotia Steel and Coal	383,285		
Co	45,087	McKay Mining Co.	562
Intercolonial...........	341,124	Cape Breton Coal Co.....	5,590
			6,546,191

TABLE 13.

COAL.

NOVA SCOTIA :—DISTRIBUTION OF COAL SOLD.

Markets.	Calendar Year.					
	1904.		1905.		1906.	
	Tons, 2,000 lbs.	Per cent.	Tons, 2,000 lbs.	Per cent.	Tons, 2,000 lbs.	Per cent.
Nova Scotia, transported by land......................	918,822	18·0	1,145,255	27·4	1,542,301	27·04
Nova Scotia, transported by sea...	724,289	14·2	485,574	9·4	594,647	10·42
Total, Nova Scotia....	1,643,111	32·2	1,900,829	36·8	2,136,948	37·46
New Brunswick............	474,053	9·3	477,360	9·2	468,273	8·21
Prince Edward Island......	95,177	1·9	85,099	1·7	77,942	1·37
Quebec	1,916,384	37·6	1,721,751	33·3	1,971,860	34.57
Newfoundland...	155,794	3·1	165,117	3·2	166,564	2·92
United States	730,658	14·3	755,433	14·6	817,672	14·33
West Indies..............	....	......	2,827	·1	....	
Other countries	82,772	1·6	59,060	1·1	65,048	1·14
Total..............	5,097,949	100·0	5,167,476	100·0	5,704,307	100·00

New Brunswick :—The production of coal in this Province has never been large, but the industry has been showing an important development during the past two years. The production in 1906 is estimated at about 34,076 short tons.

TABLE 14.

COAL.

NEW BRUNSWICK :—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1887............	10,040	$ 23,607	$2 35
1888............	5,730	11,050	1 93
1889............	5,673	11,733	2 07
1890........ ...	7,110	13,850	1 95
1891............	5,422	11,030	2 03
1892....	6,768	9,375	1 39
1893............	6,200	9,837	1 59
1894.....	6,469	10,264	1 59
1895....... ...	9,500	14,250	1 50
1896.	7,500	11,250	1 50
1897..........	6,000	9,000	1 50
1898..	6,160	9,240	1 50
1899.	10,528	15,792	1 50
1900............	10,000	15,000	1 50
1901......	17,630	51,857	2 94
1902.......... .	18,795	39,680	2 11
1903......... ...	16,000	40,000	2 50
1904............	9,112	18,224	2 00
1905.	29,400	58,800	2 00
1906............	34,076	68,152	2 00

North West Territories :—The development of the western prairies, the rapid growth of population with the accompanying demand for fuel both for domestic use and for transportation, as well as the demand for fuel by the mining and metallurgical industry of British Columbia, have been responsible for a large increase in the production of coal from what are now the new Provinces of Alberta and Saskatchewan. A small quantity is also mined for local use in the Yukon Territory.

Statistics of production show a total output in 1906 of 1,361,758 tons, as compared with 1,046,513 tons in 1905, and over twice the production in 1903.

This output includes bituminous and lignite coal, as well as a growing production of semi-anthracite from Banff.

TABLE 15.

COAL.

NORTH WEST TERRITORIES :—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1887	74,152	$ 157,577	$ 2 13
1888	115,124	183,354	1 59
1889	97,364	179,640	1 85
1890	128,953	198,498	1 54
1891	174,131	437,243	2 51
1892	184,370	469,930	2 55
1893	238,395	598,745	2 51
1894	199,991	488,980	2 45
1895	185,654	414,064	2 23
1896	225,868	606,891	2 69
1897	267,163	667,908	2 50
1898	340,088	825,220	2 43
1899	334,600	811,500	2 43
1900	351,950	839,375	2 38
1901	391,139	1,008,917	2 58
1902	478,129	1,110,521	2 32
1903	614,445	1,316,743	2 14
1904	786,617	1,591,545	2 02
1905	1,046,513	2,167,249	2 07
1906	1,361,758	2,806,908	2 06

The special features of this industry have been described by Mr. Denis of this Department as follows :—

"The following short account of the development of the western coal industry during the past year is given as the result of a visit to the various fields :—

The coal industry along the Crowsnest branch of the Canadian Pacific railway is developing very quickly. At Taber, some thirty miles east of Lethbridge, the Reliance Coal Company, which started work about a year ago, has now a very complete surface plant, and is in a position to produce 300 tons a day.

At Lethbridge, the Alberta Railway and Irrigation Company (late Alberta Railway and Coal Company), have extended their workings under the valley of the river. They are continually introducing improvements and additions at their colliery, the latest being a new Rand compressor with a free air capacity of 3,300 cubic feet a minute.

The Diamond Coal Company is at present starting to develop a colliery six miles north of Lethbridge on the opposite bank of the river. The intention of the Company is to develop the property for the next eighteen months, at which time the new Canadian Pacific Railway bridge spanning the valley is expected to be completed, and will bring the line of railway within a short distance of the mine.

At Lundbreck the Lund-Breckenridge Coal Company's mine, which was only in the development stage last year, is now the centre of quite a large settlement. It has a very complete and up-to-date surface plant, with a steel head frame sixty-five feet high. The mine only began shipping in April and has now an output of 150 to 200 tons a day. The capacity of the screens is at present 500 tons, but it is capable of large extensions.

At Frank, the Canadian-American Coal Company's principal addition to their surface works is a tipple which is now in course of construction and is designed to handle 2,000 tons a day. The main entry is now in 8,600 feet.

The Hillcrest Coal and Coke Company, whose mine is situated south-east of Frank, Alberta, on section 18, range III, township 7, west of the fifth meridian, started development in September, 1905, and the first shipment of coal was made in March, 1906. They own a spur of standard gauge railway two miles long, connecting the tipple with the Canadian Pacific railway, and have now a production capacity of 200 tons a day.

The West Canadian Collieries Company, offices at Blairmore, which has the only installation in the west of mechanical coke ovens (a set of Belgian ovens of the Bernard type), had been rather troubled by the high contents in ash of their coke. They have installed at Lille a spendidly equipped washer, designed to wash all coal sent to the coke ovens under three-quarters of an inch in size, with the result that the ash in the coke has been reduced by one-half. The washer comprises Luhrig jigs and Spitzkatsen, and can treat 300 tons in a day of ten hours ; all the labour in connexion with it is performed by one man at the engine and one labourer. Both collieries, Lille and Bellevue, were working steadily all the year.

At Coleman, the International Coal and Coke Company are building ninety additional coke ovens of beehive pattern. This will double their capacity. The colliery has a very up-to-date plant and a steady output.

The Pacific Coal Company, with mine at Bankhead, near Banff, Alberta, have completed and put in operation their large breaker, to prepare the anthracite coal for the market. It is of the best modern type and probably the most complete in North America. This coal is thoroughly divested of all friable parts so that it can stand long transportation without breaking up. The result of this preparation, however, is the production of a rather large proportion of anthracite dust. After a long series of careful experiments, the Company is erecting a briquetting plant to use this dust. The plant, which may be in operation at the close of the year, will produce 200 tons of briquets per day. The presses adopted are of the Zwoier pattern.

In the Edmonton district, all the coal mines have been very active, and everywhere provision was being made for a greatly increased output. The city of Edmonton has been growing very rapidly, and the market for coal has naturally grown in proportion.

The feature of the year in the district has been the inauguration of mining by shafts. Previously, all the mines were worked by tunnels driven into the banks of the Saskatchewan river, but there are now three mines that have sunk shafts from 60 to 195 feet. The individual production of the mines is so far small, the largest not exceeding 200 tons in two shifts."

British Columbia :—Statistics of coal production in British Columbia since 1836 are shown in table 16 following. The output in 1906 was the largest yet recorded and showed an increase of more than 10 p. c. over the output in 1905.

The production during 1906 has been well described by the Provincial Mineralogist in the annual report of the Minister of Mines for British Columbia as follows :—

"During the year 1906 the actual production of coal in British Columbia has as yet been confined to the two well known districts, the collieries in the vicinity of the Crowsnest pass, and the collieries on Vancouver island.

In the former of these districts the Crow's Nest Pass Coal Co. has been operating collieries at Michel, Coal Creek, and, for the first portion of the year, at Carbonado ; but latterly this last colliery has been closed down.

The collieries on Vancouver island have been operated by two companies, the Western Fuel Co. at Nanaimo, and the Wellington Colliery Co. at Ladysmith and Comox.

The gross output of the coal mines of the Province for the year was 1,899,076 tons (2,240 lbs.), which, with 17,230 tons taken from stock, makes a total consumption of 1,916,306 tons. Of this total amount, 1,361,728 tons were sold as coal, of which 681,899 tons were for consumption in Canada and 679,829 tons were exported ; while 381,773 tons were used in making coke, and 172,805 tons were used under the Company's boilers, etc., or sold locally.

The amount of coke made was 199,227 tons (2,240 lbs.), which, together with 11,670 tons taken from stock, made the sales for the year 210,897 tons.

The following table indicates the markets in which the coal and coke output of the Province was sold :—

Coal.	Coast.	Crowsnest pass.	Total.
Sold for consumption in Canada, tons, 2,240 lbs	531,106	150,793	681,899
Sold for export to United States, lbs	433,183	230,863	664,046
Sold for exports to other countries, lbs	15,783	....	15,783
	980,072	381,656	1,361,728
Coke.			
Sold for consumption in Canada	14,547	134,646	149,193
Sold for export to United States	8,304	53,400	61,704
Sold for export to other countries	.....	.....	.....
	22,851	188,046	210,897

VANCOUVER ISLAND COLLIERIES.

The Vancouver Island collieries mined in 1906 some 1,178,627 tons (2,240 lbs.) of coal, which, with 17,230 tons taken from stock, makes the total amount of coal disposed of 1,195,857 tons, distributed as follows :—

	Long tons.
Sold as coal in Canada	531,106
" United States	433,183
" other countries	15,783
Total sold as coal	980,072
Used under companies' boilers, etc	138,057
Used in making coke	77,728
	1,195,857

The total coal sales of the coast collieries show an increase of 172,042 long tons, or about 21·3 p.c. over the preceding year. The amount of coal exported to the United States is very little greater than it was last year, but amounts to about 45·8 p.c. of the total sales. The chief market for this coal is still San Francisco, although Alaska, with its increasing requirements for mining and smelting, has become an important factor in the export trade, and promises to become greater. The consumption of coal in that portion of British Columbia served by the Coast collieries shows a marked increase, being 150,774 long tons, or 39·6 p.c. greater than during the preceding year.

The production of coke on the Coast is confined to one company, the Wellington Colliery Co., which made in 1906 only 9,842 long tons; but took from its stock piles some 13,009 tons, making the coke sales 22,851 tons, of which amount 14,547 tons were sold locally, and 8,304 tons were exported, chiefly to Alaska points. The local consumption of coke shows an increase of 9,137 tons, or 169 p.c., due to the active operations of the Vancouver Island copper smelters. The increase in the amount of coke exported is equally marked, being 4,004 tons, or 93 p.c., and is due to the constantly increasing copper smelting operations carried on in Alaska.

While these increases are very considerable, they are not nearly as great as they would have been but for the shortage of labour at the various collieries, which were, therefore, quite unable to satisfy the demand for fuel. A fuel famine seemed to be imminent, and, as a matter of fact, in the spring of 1907 coke had to be and was imported, a cargo of some 3,000 tons having been received by the Crofton smelter from Australia.

The selling price of coal has also advanced very much, so much so that local coal dealers are charging $7.75 for 2,000 lbs. of coal delivered for domestic use.

CROWSNEST PASS COLLIERIES.

In the Rocky Mountain coal field, the collieries in British Columbia are all operated by the Crow's Nest Pass Coal Company, although over the boundary in the Province of Alberta there are three or four other companies operating. The Crow's Nest Pass Coal Company operated collieries at Michel, Coal Creek, and at Carbonado (Morrissey); the latter, however, was shut down on April 1 and has not since resumed operations. This Company mined during the year 720,449 tons (2,240) of coal, the disposition of which is shown in the following table :—

	Long tons.	
Sold as coal in Canada	150,793	
" United States	230,863	
		381,656
Used by Company in making coke		304,045
" under Companies' boilers, etc		34,748
		720,449

The amount of coke produced from the coal noted above was 189,385 long tons, of which 1,339 tons were carried over the year as stock, and 188,046 tons sold; some 134,646 tons for consumption in Canada, all in British Columbia, while 53,400 tons were exported to the United States. The coal sales of the Crow's Nest Company this year are less than during the preceding year by 13,285 tons, or 3·3%. The coke sales also show a decrease of 70,335 tons, or 27·2%. These decreases are accounted for by the fact that in the fall a labour strike closed the mines for six weeks or two months, and later the unusually heavy snow fall blocked the railways to such an extent that they were unable to move the coal."

TABLE 16.

COAL.

BRITISH COLUMBIA :—PRODUCTION.

Calendar Year.	Output Tons, 2,240 lbs.	Home Consumption, Tons, 2,240 lbs.	Sold for Export, Tons, 2,240 lbs. ‡	PRODUCTION.* Tons, 2,240 lbs.	PRODUCTION.* Tons, 2,000 lbs.	Price per ton, 2,240 lbs	Value.
						$	$
1836-52..	10,000				11,200	4 00	40,000
1852-59..	25,398				28,446	4 00	101,592
1859¶...	1,989				2,228	4 00	7,956
1860.....	14,247				15,957	4 00	56,988
1861.....	13,774				15,427	4 00	55,096
1862.....	18,118				20,292	4 00	72,472
1863.....	21,345	From 1836 to 1873 inclusive, the output is taken as production.			23,906	4 00	85,380
1864.....	28,632				32,068	4 00	114,528
1865.....	32,819				36,757	4 00	131,276
1866.....	25,115				28,129	4 00	100,460
1867. ..	31,239				34,988	4 00	124,956
1868.....	44,005				49,286	4 00	176,020
1869.....	35,802				40,098	4 00	143,208
1870.....	29,843				33,424	4 00	119,372
1871-2-3.	148,459				166,274	4 00	593,836
1874.....	81,547	25,023	56,038	81,061	90,788	3 00	243,183
1875.....	110,145	31,252	66,392	97,644	109,361	3 00	292,932
1876.....	139,192	17,856	†122,329	140,185	157,007	3 00	420,555
1877.....	154,052	24,311	115,381	139,692	156,455	3 00	419,076
1878.. ..	170,846	26,166	164,682	190,848	213,750	3 00	572,544
1879.....	241,301	40,294	192,096	232,390	260,277	3 00	697,170
1880. ...	267,595	46,513	225,849	272,362	305,045	3 00	817 086
1881.....	228,357	40,191	189,323	229,514	257,056	3 00	688,542
1882.....	282,139	56,161	232,411	288,572	323,201	3 00	865,716
1883.....	213,299	64,786	149,567	214,353	240,075	3 00	643,059
1884. ...	394,070	87,388	306,478	393,866	441,130	3 00	1,181,598
1885.....	365,596	95,227	237,797	333,024	372,987	3 00	999,072
1886.....	326,636	85,987	249,205	335,192	375,415	3 00	1,005,576
1887....	413,360	99,216	334,839	434,055	486,142	3 00	1,302,165
1888.....	489,301	115,953	365,714	481,667	539,467	3 00	1,445,001
1889.....	579,830	124,574	443,675	568,249	636,439	3 00	1,704,747
1890.....	678,140	177,075	508,270	685,345	767,586	3 00	2,056,035
1891.....	1,029,097	202,697	806,479	1,009,176	1,130,277	3 00	3,027,528
1892	826,335	196,223	640,579	836,802	937.218	3 00	2,510,406
1893.....	978,294	207,851	768,917	976,768	1,093,980	3 00	2,930,304
1894.....	1,012,953	165,776	827,642	993,418	1,112,628	3 00	2,980,254
1895.....	939,654	188,349	756,334	944,683	1,058,045	3 00	2,834,049
1896.....	894,882	261,984	634,238	896,222	1,003,769	3 00	2,688,666
1897.....	892,296	290,310	619,860	910,170	1,019,390	3 00	2,730,510
1898....	1,136,485	375,423	752,863	1,128,286	1,263,680	3 00	3,384,858
1899.....	1,306,324	526,058	751,711	1,277,769	1,431,101	3 00	3,833,307
1900. ...	1,590,178	685,667	914,184	1,599,851	1,791,833	3 00	4,799,553
1901.....	1,691,557	799,666	914,163	1,713,829	1,919,488	3 00	5,141,487
1902.....	1,641,626	837,871	776,809	1,614,680	1,808,441	3 00	4,844,040
1903.....	1,450,663	947,499	549,449	1,496,948	1,676,581	3 00	4,490,844
1904.....	1,685,698	1,129,465	533,593	1,663,058	1,862,625	3 00	4,989,174
1905.....	1,736,696	1,089,667	647,343	1,737,010	1,945,452	3 00	5,211,030
1906.....	1,899,076	1,236,476	679,829	1,916,305	2,146,262	3 00	5,748,915

*This production is obtained by adding 'Home Consumption' and 'Sold for Export.'

†52,935 tons of this amount were exported as sales without the division into the 'Home Consumption' and 'Sold for Export.'

‡ The figures in the 'Sold for Export' column do not agree as they should with those given in table 5, the only explanation being that the data in the two cases are from different sources, and it has not been possible to find out the cause of the difference.

¶ Two months only.

Mr. Denis, who visited some of the coal fields in this district also, refers to some of the coal properties being developed as follows :—

" On the British Columbia side of the Crowsnest pass the coal industry has been very active. One of the noteworthy features is the start which the Canadian Pacific railway is making to mine coal at Hosmer, a station on the railway about eight miles north of Fernie. The work, up to July, had mainly been of a prospecting nature, but there seems to be little doubt that an important colliery will soon be added to those of the Crowsnest pass.

" The Imperial Coal Company own some coal lands on Fording river, a tributary of the Elk river, above Michel creek, and have begun surveys for a line of railway to tap their areas.

" So far, the only producing coal company of the Crowsnest Pass field, is the Crow's Nest Pass Coal Company. This Company has two collieries working actively, at Coal creek and at Michel, and a third one at Carbonado, on which a great deal of work has been done, but which is not producing at present. The year's main improvements at these two collieries have been the completion of a steel tipple at Coal creek, designed to handle an output of 4,000 tons in 10 hours, and the installation of compressed air haulage at the Michel colliery to replace horse haulage. Practically one-half of the coal output is used in the manufacture of coke, which is shipped to the West Kootenay smelters, or exported.

"The Nicola valley is now entered by a branch line of the Canadian Pacific railway from Spences Bridge. It is expected that this will be open for traffic during the autumn. The transport facilities thus afforded should be an incentive to prospecting for coal in this region. Coal certainly occurs there, but nothing very definite is yet known as to the extent of the fields. The Diamond Vale Company have been the most active in the work of prospecting. They have a diamond drill at work continuously on their Quilchena area.

" A couple of diamond drill holes were also bored during the year in the valley between the Coldwater and the Nicola rivers."

COKE.

Oven coke is made in Nova Scotia, Alberta, and British Columbia. The total quantity of coal charged to ovens during 1906 was 1,297,340 short tons, from which there was produced 768,280 tons of coke, as well as certain by-products from the ovens of the Dominion Iron and Steel Co. at Sydney.

The production by provinces was as follows in tons of 2,000 lbs.:—

Province.	Coal charged to ovens.	Output of coke.	Stock on Hand.		Coke sold or used.	Value of sales, etc.
			Jan. 1.	Dec. 31.		
	Tons.	Tons.	Tons.	Tons.	Tons.	$
Nova Scotia.	765,819	475,773	1,436	845	476,364	1,540,976
Alberta. . . .	103,936	69,372	3,800	3,686	69,486	268,042
Br. Columbia.	427,585	223,135	14,815	1,745	236,205	1,054,485
	1,297,340	768,280	20,051	6,276	782,055	2,863,503

In 1905 the amount of coke sold or used was 700,488 tons, the increase in 1906 being, therefore, 81,567 tons or 11·64 p. c. This increase is mainly due to the growth of the iron and steel metallurgical industries of Nova Scotia, and to the demand for coke for use in the smelting furnaces of British Columbia. Statistics of production since 1886 are shown in tables 1 and 2 following :—

Table 1.
Coke.
Annual Production.

Calendar Year.	Tons.	Value.	Value per ton.
1886	35,396	$101,940	$2.88
1887	40,428	135,951	3.36
1888	45,373	134,181	2.96
1889	54,539	155,043	2.84
1890	56,450	166,298	2.95
1891	57,084	175,592	3.08
1892	56,135	160,249	2.85
1893	61,078	161,790	2.65
1894	58,044	148,551	2.56
1895	53,356	143,047	2.68
1896	49,619	110,257	2.22
1897	60,686	176,457	2.91
1898	87,600	286,000	3.26
1899	100,820	350,022	3.47
1900	157,134	649,140	4.13
1901	365,531	1,228,225	3.36
1902	502,043	1,519,185	3.03
1903	561,318	1,734,404	3.09
1904	554,083	2,032,048	3.66
1905	700,488	2,436,211	3.48
1906	782,055	2,863,503	3.66

TABLE 2.

COKE.

PRODUCTION OF COKE BY PROVINCES.

Calendar Year.	Nova Scotia.		British Columbia.		N. W. Territories.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$
1897..........	41,532	90,950	19,154	85,507	....	....
1898..........	48,400	111,000	39,200	175,000	....	....
1899..........	62,459	178,767	38,361	171,255	....	....
1900..........	61,767	223,395	95,367	425,745	....	....
1901..........	222,694	590,560	142,837	637,665	....	....
1902..........	363,330	899,930	138,713	619,255	....	....
1903..........	371,745	888,094	189,573	846,310	....	....
1904..........	275,927	805,022	257,172	1,148,090	20,984	78,936
1905..........	386,366	1,054,712	269,256	1,202,035	44,866	179,464
1906..........	476,364	1,540,976	236,205	1,054,485	69,486	268,042

The production in the Province of Nova Scotia is all consumed within that Province. In British Columbia, however, a large portion of the output is exported to the United States. According to direct returns from the companies the quantity of coke sold for export was 69,109 short tons.

This statement of export differs considerably from the figures of export published by the Department of Customs, according to which authority the actual exports were only 37,003 tons (see table 3).

The imports of coke in 1906 were 480,222 tons, chiefly for use in the iron blast furnaces in Ontario.

Statistics of exports and imports of coke, as compiled from the Trade and Navigation reports, are shown in tables 3 and 4.

Table 3.

Coke.

Exports of Coke.

Calendar Year.	Tons.	Value.
		$
1897	2,987	6,078
1898	3,774	8,394
1899	5,557	18,726
1900	41,529	131,278
1901	57,505	176,990
1902	62,568	180,920
1903	32,608	135,957
1904	102,463	345,031
1905	116,071	509,908
1906	37,003	168,571

Table 4.

Coke.

Imports of Oven Coke.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
		$			$
1880	3,837	19,353	1894	42,864	176,996
1881	5,492	26,123	1895	43,235	149,434
1882	8,157	36,670	1896	61,612	203,826
1883	8,943	38,588	1897	83,330	267,540
1884	11,207	44,518	1898	135,060	347,040
1885	11,564	41,391	1899	141,284	362,826
1886	11,858	39,756	1900	187,878	506,839
1887	15,110	56,222	1901	308,786	680,138
1888	25,487	102,334	1902	267,142	842,815
1889	29,557	91,902	1903	256,723	1,222,756
1890	36,564	133,344	1904	221,050	765,123
1891	38,533	177,605	1905	371,593	807,842
1892	43,499	194,429	1906....Duty free	480,222	1,311,375
1893	41,821	156,277			

PEAT.

Although the production of peat fuel cannot yet be said to have become a well established industry in Canada, there has been a good deal of experimental work in progress at different times and in different localities, which has resulted during the past six years in a small annual production of peat. During 1906 the Condensed Peat Fuel Company, Ltd., of Peterboro, for five months operated their plant $\frac{3}{4}$ of a mile north of Victoria Road, Ontario, and the Montreal and Ottawa Peat Company, Limited, worked for four months on the bog in the township of Alfred, Prescott county. A total of 474 tons of peat was sold, valued at $1,422.

The Interwest Peat Fuel Co., of Winnipeg, were installing machinery and preparing to operate their bog at Lac du Bonnet, Man. Sales of peat during the past seven years have been reported as follows:—

Year.	Tons.	Value.
1900	400	$ 1,200
1901	220	600
1902	475	1,663
1903	1,100	3,300
1904	800	2,400
1905	80	260
1906	474	1,422

GRAPHITE.

Graphite was mined in Quebec Province during 1906 by the Calumet Mining and Milling Graphite Co., at Calumet, Que., the Diamond Graphite Co., Buckingham, Que., and the Bell Mines, Buckingham, Que., none of which, however, made any shipments. The Buckingham Graphite Co., of Buckingham, shipped a quantity of milled product held over from previous years. In Ontario the Black Donald mine in Brougham tp., was operated by the Ontario Graphite Co., Ltd., and the Elmsley mines, North Elmsley, Lanark Co., by the Globe Refining Co., Ltd., both of Ottawa.

The total quantity of graphite mined was 3,922 tons, of which 1,500 tons were milled. The sales and shipments were 222 tons of crude ore valued at $5,000, and 165 tons of milled graphite valued at $13,300, or a total of 387 tons valued at $18,300.

The value of the imports of plumbago, black-lead and other manufactures of plumbago during 1906 reached a total of $88,106.

Annual statistics of the production, exports and imports of graphite are shown in the following tables :—

TABLE 1.

GRAPHITE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1886............	500	$4,000	1896...........	139	$ 9,455
1887............	300	2,400	1897....	436	16,240
1888............	150	1,200	1898....	....	13,698
1889....	242	3,160	1899............	1,130	24,179
1890........... .	175	5,200	1900............	1,922	31,040
1891............	260	1,560	1901............	2,210	38,780
1892............	167	3,763	1902............	1,095	28,300
1893............	Nil.	Nil.*	1903.	728	23,745
1894*..........	3	223	1904............	452	11,760
1895............	220	6,150	1905............	541	16,735
			1906............	387	18,300

* Exports.

TABLE 2.

GRAPHITE.

EXPORTS.

Calendar Year.	Value.	Calendar Year.	Value.
1886	$ 3,586	1896	$ 9,480
1887	3,017	1897	4,325
1888	1,080	1898	13,098
1889	538	1899	22,490
1890	1,529	1900	46,197
1891	72	1901	35,102
1892	3,952	1902	24,839
1893	38	1903	43,642
1894	223	1904	16,567
1895	4,833	1905	8,114

	Cwt.	$
1906 Crude	2,121	2,468
1906 Manufactures of		5,274
		$ 7,742

TABLE 3.

GRAPHITE.

IMPORTS OF RAW AND MANUFACTURED GRAPHITE.

Fiscal Year.	Plumbago.	Manufactures of plumbago.	
		Black-lead.	Other Manufactures.
1880	$1,677	$18,055	$2,738
1881	2,479	26,544	1,202
1882	1,028	25,132	2,181
1883	3,147	21,151	2,141
1884	2,891	24,002	2,152
1885	3,729	24,487	2,805
1886	5,522	23,211	1,408
1887	4,020	25,766	2,830
1888	3,802	7,824	22,604
1889	3,546	11,852	21,789
1890	3,441	10,276	26,605
1891	7,217	8,292	26,201
1892	2,988	13,560	23,085
1893	3,293	16,595	23,051
1894	2,177	17,614	16,686
1895	2,586	13,922	21,988
1896	2,865	18,434	19,497
1897	1,406	17,863	20,674
1898	1,862	19,638	32,653
1899	4,979	21,334	36,490
1900	4,437	22,078	38,440
1901	2,357	25,646	49,890
1902	3,649	20,467	43,656
1903	2,870	22,559	47,117
1904	1,802	26,053	41,510
1905	2,499	30,743	44,545

	Duty.			
1906 Plumbago, not ground, etc.	10 p.c.	....	....	....
1906 Black-lead	25 "	$2,791	$33,907	....
1906 Plumbago ground, and manufactures of N.E.S.	25 "	....	....	$19,058
1906 Crucibles, clay or plumbago	Free..	....	....	32,350
Total, 1906	....	$2,791	$33,907	$51,408

Artificial graphite:—The manufacture of artificial graphite in electric furnaces has been carried on for some years at Niagara Falls, New York, by the International Atcheson Graphite Company. A small plant has now been established on the Canadian side of the river at Niagara Falls, Ont., and the quantity of artificial graphite made during 1906 is reported by the manufacturers as 445,047 pounds.

GYPSUM.

Gypsum is mined in Canada chiefly in the Provinces of Nova Scotia and New Brunswick, also in small quantities in the Province of Ontario and in the northern part of Manitoba.

In 1906 the total quantity of gypsum mined was 492,759 short tons, of which 28,831 tons are reported as having been calcined. The total quantity mined in 1905 was 443,569 short tons, of which 26,855 tons were calcined.

The figures of production as given in table 1 represent the total sales and shipments of crude, ground and calcined gypsum, which in 1906 were 469,022 tons valued at $643,294, as compared with total sales in 1905 of 442,158 tons valued at $586,168, showing an increase in 1906 of 26,864 tons or 6 per cent in quantity, and of $56,126 or 9·7 per cent in value.

The production during the past two or three years has shown an important growth, and the output is now double what it was in 1898.

The average price of the crude gypsum shipped in 1906 was $1.07 per short ton, as compared with an average of 99 cents in 1905 and 76 cents in 1904.

TABLE 1.
GYPSUM.
ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Average price per ton.
1886	162,000	$178,742	$ 1.10
1887	154,008	157,277	1.02
1888	175,887	179,393	1.01
1889	213,273	205,108	0.96
1890	226,509	194,033	0.86
1891	203,605	206,251	1.01
1892	241,048	241,127	1.00
1893	192,568	196,150	1.02
1894	223,631	202,031	0.90
1895	226,178	202,608	0.89
1896	207,032	178,061	0.86
1897	239,691	244,531	1.02
1898	219,256	232,515	1.06
1899	244,566	257,329	1.05
1900	252,101	259,009	1.02
1901	293,799	340,148	1.16
1902	333,599	379,479	1.14
1903	314,489	388,459	1.24
1904	345,961	373,474	1.08
1905	442,158	586,168	1.32
1906 Crude Gypsum	442,132	473,960	1.07
1906 Ground Gypsum	3,195	9,823	3.07
1906 Plaster of Paris, and wall plaster	23,695	159,511	6.73
Total	469,022	643,294	1.57

TABLE 2.

GYPSUM.

ANNUAL PRODUCTION BY PROVINCES.

Calendar Year.	Nova Scotia.		N. Brunswick.		Ontario.		Manitoba.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1887......	116,346	116,346	29,102	29,216	8,560	11,715		
1888......	124,818	120,429	44,369	48,764	6,700	10,200		
1889......	165,025	142,850	40,866	49,130	7,382	13 128		
1890......	181,285	154,972	39,024	30,986	6,200	8,075		
1891......	161,934	153,955	36,011	33,996	5,660	18,300		
1892......	197,019	170,021	39,709	65,707	4,320	5,399		
1893......	152,754	144,111	36,916	41,846	2,898	10,193		
1894......	168,300	147,644	52,962	48,200	2,369	6,187		
1895......	156,809	133,929	66,949	63,839	2,420	4,840		
1896......	136,590	111,251	67,137	59,024	3,305	7,786		
1897......	155,572	121,754	82,658	118,116	1,461	4,661		
1898......	132,086	106,610	86,083	121,704	1,087	4,201		
1899......	126,754	102,055	116,792	151,296	1,020	3,978		
1900......	138,712	108,828	112,294	145,850	1,095	4,331		
1901......	170,100	136,947	121,595	189,709	1,504	5,692	600	7,800
1902......	206,087	181,425	124,041	170,153	1,917	7,699	1,554	20,202
1903......	189,427	173,881	119,182	172,080	2,720	21,988	3,160	20,510
1904......	218,580	153,600	190,991	187,524	2,390	18,350	4,000	14,000
1905......	272,252	298,248	163,553	232,586	1,853	23,834	4,500	31,500
1906......	333,312	345,414	131,246	250,960	2,965	24,420	3,200	22,500

The greater part of the gypsum mined in Nova Scotia is shipped in the crude state, though a small quantity is ground or calcined by the Windsor Plaster Company at Windsor, N.S. The total sales during the year in this Province were 333,312 tons valued at $345,414, which is an increase of 61,060 tons over the sales during 1905.

The older quarries at Windsor and Walton have not only increased their shipments, but the Victoria Gypsum Mining and Manufacturing Co., which has been developing a property at St. Anns, C.B., for several seasons, has reached the shipping stage and made an important contribution to the output.

At Amherst also the Maritime Gypsum Co. have commenced shipping from the quarry which they have opened in this vicinity. From the Province of New Brunswick the total shipments of crude and calcined gypsum, etc., were 131,246 tons valued at $250,960, of which 113,972 tons were crude gypsum and 17,274 calcined and ground. Compared with the shipments of 1905 and 1904 a considerable decrease in output is evidenced. The production is derived mainly from the deposits at Hillsborough, Albert county, in which the most important operator is the Albert Manufacturing Company ; while a small production is annually made from the deposits on the Tobique river.

In Ontario small quantities of gypsum have as usual been mined from deposits found along the Grand river. The product is chiefly utilized in the manufacture of wall plaster and alabastine, etc.

In Manitoba the gypsum is quarried north of Lake St. Martin and shipped to Winnipeg, where it is calcined for use as wall plaster by the Manitoba Gypsum Co., Ltd.

Statistics of exports and imports of gypsum products as compiled from the Trade and Navigation reports are shown in tables 3, 4 and 5, following :—

TABLE 3.
GYPSUM.
EXPORTS OF CRUDE GYPSUM.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1874	67,830	68,164	....	....	.....	....	67,830	68,164
1875	86,065	86,193	5,420	5,420	......	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	180	92,765	94,386
1877	106,950	93,867	5,030	5,030	....	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	.....	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	......	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	.....	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	.. .	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	.....	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	......	....	189,206	197,150
1898	99,215	93,474	70,399	81,433	.....	....	169,614	174,907
1899	104,795	99,984	96,831	108,094	*½	12	201,626	208,090
1900	....	....	....	....	......	....	188,262	201,912
1901	....	....	....	....	......	....	236,247	231,594
1902	....	....	....	....	......	.... ..	289,600	295,215
1903	....	....	....	....	......	....	287,496	311,580
1904	....	.. . .	....	... .	....	....	298,211	316,436
1905	....	....	....	....	...	....	359,246	388,474
1906							404,464	462,814

*Exported from British Columbia.

TABLE 4.
GYPSUM.
EXPORTS OF GROUND GYPSUM.

Calendar Year.	Nova Scotia.	New Brunswick.	Ontario.	Total.
	$	$	$	$
1890.............	....	....	....	105
1891.............	....	....	.. . .	588
1892...........	....	....	.. ..	20,255
1893.............	....	....	....	22,132
1894.............	2,124	17,930	....	20,054
1895.............	3,364	18,827	42	22,233
1896.............	1,270	19,246	751	21,267
1897........... ..	1,655	5,024	84	6,763
1898....... ...	1,548	4,900	....	6,448
1899.............	205	7,898	20	8,123
1900.....	....	....	....	19,834
1901.....	... .	....	....	15,337
1902.............	....	....	....	5,101
1903.......	....	....	....	12,457
1904.............	....	....	.... . .	2,333
1905.	....	. ...	....	2,673
1906...	....	....	....	2,934

TABLE 5.

GYPSUM.

IMPORTS OF GYPSUM, ETC.

Fiscal Year.	Crude Gypsum.		Ground Gypsum.		Plaster of Paris.	
	Tons.	Value.	Pounds.	Value.	Pounds.	Value.
1880	1,854	$3,203	1,606,578	$ 5,948	667,676	$ 2,376
1881	1,731	3,442	1,544,714	4,676	574,006	2,864
1882	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884	....	3,416	687,432	1,936	782,920	5,226
1885	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887	1,557	2,492	13,266	73	594,146	4,342
1888	1,236	2,193	106,068	558	942,338	6,662
1889	1,360	2,472	74,390	372	1,173,996	8,513
1890	1,050	1,928	434,400	2,136	693,435	6,004
1891	376	640	36,500	215	1,035,605	8,412
1892	626	1,182	310,250	2,149	1,166,200	5,595
1893	496	1,014	140,830	442	552,130	3,143
1894	....	1,660	23,270	198	422,700	2,386
1895	603	960	20,700	88	259,200	1,619
1896	1,045	848	64,500	198	297,000	2,000
1897	....	772	45,000	123	969,900	4,489
1898	1,147	1,742	35,700	293	329,600	2,025
1899	325	692	33,900	338	496,300	3,120
1900	77	958	6,300	69	849,100	6,492
1901	286	1,125	65,400	1,097	502,200	3,978
1902	541	1,697	56,700	249	475,300	2,641
1903	1,076	2,187	68,700	228	630,800	3,599
1904	249	663	106,800	559	625,100	2,885
1905	2,344	7,386	2,255,700	2,681	7,924,100	37,643
1906	6,332	22,008	*1,968,690	1,799	12,866,500	43,742

*Equivalent to 6,562 barrels.

Crude gypsum, duty free. Ground gypsum, duty 15%. Plaster of Paris, duty 12½c. per 100 lbs.

MANGANESE.

Manganese was formerly an important mineral product in Nova Scotia and New Brunswick. In recent years, however, there has been but little mining of the mineral, what output there was, coming from the working over of old dumps. No direct returns of production were received during the past two years. The Customs Department reports an export of manganese ore during 1905 of 22 tons, and during 1906 of 93 tons. These figures have been utilized to represent the production. Statistics showing the production and exports of manganese ore are shown in tables 1 and 2, while the imports of oxide of manganese are shown in table 3.

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1886	1,789	$41,499	$23.20
1887	1,245	43,658	35.07
1888	1,801	47,944	26.62
1889	1,455	32,737	22.50
1890	1,328	32,550	24.51
1891	255	6,694	26.25
1892	115	10,250	89.13
1893	213	14,578	68.44
1894	74	4,180	56.49
1895	125	8,464	67.71
1896*	123½	3,975	32.19
1897*	15¼	1,166	76.46
1898	50	1,600	32.00
1899	1,581	20,004	12.65
1900	30	1,800	60.00
1901*	440	4,820	10.95
1902*	172	4,062	23.62
1903	91	2,775	30.49
1904	66	2,740	41.51
1905*	22	1,720	78.18
1906*	93	925	9.95

* Exports.

TABLE 2.
MANGANESE.
EXPORTS OF MANGANESE ORE.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	....	....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	11,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(a) 441	30,854	1,377	27,484	(a)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	$\frac{3}{10}$	3	$108\frac{3}{10}$	6,351
1896	$123\frac{1}{2}$	3,975	....	....	$123\frac{1}{2}$	3,975
1897	$15\frac{1}{4}$	1,166	....	....	$15\frac{1}{4}$	1,166
1898	11	325	....	....	11	325
1899	67	2,328	3	82	70	2,410
1900	....	....	....	....	34	1,720
1901	....	....	....	....	440	4,820
1902	....	....	....	....	172	4,062
1903	....	....	....	....	135	1,889
1904	....	....	....	....	123	2,706
1905	....	....	....	....	22	1,720
1906	....	....	....	....	93	925

(a) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

TABLE 3.
MANGANESE.
IMPORTS: OXIDE OF MANGANESE.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1884	3,989	$ 258	1895	64,151	$2,781
1885	36,778	1,794	1896	108,590	4,075
1886	44,967	1,753	1897	70,663	2,741
1887	59,655	2,933	1898	130,456	5,047
1888	65,014	3,022	1899	141,356	5,539
1889	52,241	2,182	1900	126,725	4,155
1890	67,452	3,192	1901	272,134	8,176
1891	92,087	3,743	1902	476,331	5,360
1892	76,097	3,530	1903	279,611	8,051
1893	94,116	3,696	1904	275,696	7,051
1894	101,863	4,522	1905	235,289	6,832
			1906 Duty Free...	244,620	5,508

MICA.

Mica mining has become an important industry in Eastern Canada in both the Provinces of Ontario and Quebec. In the former Province mining at present is carried on chiefly in the district immediately north of the city of Ottawa, in the townships of Hull, Templeton and Wakefield, etc., while in Ontario the chief mines are located in the counties of Frontenac, Lanark and Leeds. The mica is used largely in the manufacture of electrical machinery and applicances ; to such an extent in fact that, several of the large electrical manufacturing companies have become directly interested in the mining of the mineral. The principal market for the Canadian product is in the United States, although important quantities are now being exported to Europe, where Canadian mica comes in competition with mica from India.

The annual statistics of production which have been published have been somewhat unsatisfactory for several reasons. In the first place there has been a considerable production of mica by small operators who sell to regular buyers, but of which it is difficult to obtain satisfactory record, and in the next place, and of greater importance, the value of the mica suffers a wide variation from the rough cobbed condition in which it leaves the mine to the prepared and selected mica as it leaves the trimming factories. In many cases returns received from operators show the value of the rough cobbed mica only, while in others the product is valued according to the condition in which it is sold. There are also frequently large stocks of mica carried over from one year to another, awaiting a favourable turn in the market. It may be safely assumed, therefore, that the published statistics do not represent the full value of the mica as it leaves the country.

Returns from producers in 1906 showed total shipments of 574 tons valued at $303,913, or an average value per ton of $529.46 as follows, by provinces :—

Province.	Tons.	Value.	Value per ton.
Quebec..................	283	$ 159,334	$ 563.02 ;
Ontario..............	291	144,579	495.84 ;
Total..	574	$ 303,913	$ 529.46.

The average value per ton from individual mines ranged from $208 to $806.

The exports of mica according to Customs Department statistics were, during the calendar year 1906, as follows :—

——	Tons.	Value.	Average Value per ton.
To Great Britain..........	167	$ 58,735	$ 351.71
To United States............	735	519,479	706.77
To other countries...........	10	3,705	370.50
Total............	912	$ 581,919	$ 638.07

The imports of mica into the United States from Canada, according to the United States reports on "Commerce and Navigation", were, during the 12 months ending June 1906, 539 tons valued at $328,991, or an average of $610.37 per ton ; and during the 12 months ending June 1907, 766 tons valued at $596,321, or an average of $777.48 per ton.

The statistics of the production of mica in Quebec and Ontario, as collected and published by the Provincial Bureaus, are as follows :—

*Quebec**—

——	Pounds.	Value.	Average Value per lb.
Mica cutting 1/2 inch....................	106,478	$ 13,327	$0.125
1/3 "	112,896	20,755	.183
2/3 "	75,968	30,048	.395
2/4 "	65,565	36,232	.552
3/5 "	25,956	18,061	.695
4/6 "	9,512	8,891	.934
5/8 "	923	760	.823
Total...............	397,298	$128,074	.322
Split mica...........................	72,788	22,973	.315
To this must be added 87 tons of rough-culled mica which we estimate as having yielded about 60,000 lbs. of merchantable mica....................		17,840	.297
Total...............	530,086	$168,887	

* Mining operations in the Province of Quebec 1906, J. Obalski.

Ontario—

According to the Report of the Ontario Bureau of Mines, the production of rough cobbed mica in Ontario in 1906 was 355 tons valued at $69,041, or an average of $194 per ton.

TABLE 1.

MICA.

ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1886	$ 29,008	1897	$ 76,000
1887	29,816	1898	118,375
1888	30,207	1899	163,000
1889	28,718	1900	166,000
1890	68,074	1901	160,000
1891	71,510	1902	135,904
1892	104,745	1903	177,857
1893	75,719	1904	160,777
1894	45,581	1905	178,235
1895	65,000	1906, 912 tons	303,913
1896	60,000		

TABLE 2.

MICA.

EXPORTS.

Calendar Year.	Value.	Calendar Year.	Value.
1887	$ 3,480	1897	$ 69,101
1888	23,563	1898	110,507
1889	30,597	1899	153,002
1890	22,468	1900	146,750
1891	37,590	1901	152,553
1892	86,562	1902	(*a*) 391,812
1893	70,081	1903	196,020
1894	38,971	1904	198,482
1895	48,525	1905	179,049
1896	47,756	1906	581,919

(*a*) Probably includes some material manufactured from mica.

TABLE 3.

MICA.

* IMPORTS OF MICA INTO THE UNITED STATES FROM CANADA, YEARS ENDING JUNE 30.

Fiscal Year.	Pounds.	Value.
1895	546,905	$ 39,637
1896	570,750	53,719
1897	404,080	53,399
1898	465,779	53,854
1899	1,024,098	131,310
1900	1,097,067	136,981
1901	967,904	161,741
1902	854,167	184,287
1903	834,035	196,456
1904	573,035	137,191
1905	506,917	121,560
1906	1,078,267	328,991
1907	....	596,322

* The Foreign Commerce and Navigation of the United States.

MINERAL PIGMENTS.

The production of ochres and barytes only are included under this heading.

OCHRES.

The production of ochres in 1906 was 6,758 tons valued at $36,125, as compared with 5,195 tons in 1905 valued at $34,675. With the exception of 18 tons in 1906 all the output was derived from the iron oxide deposits near Three Rivers, Champlain county, Que. Only a portion of the output in this district is used for the manufacture of paint: 2,262 short tons valued at $30,005 were so used in 1906; the balance, 4,480 tons valued at $6,000, representing the crude iron oxide which is shipped to several cities in Canada and exported to the United States and used in the purification of gas.

The firms mining ochres are as follows :—

Canada Paint Co., Montreal, Que.

Champlain Oxide Co., Three Rivers, Que.

Thomas H. Argall, " "

Ontario Mineral Paint Works, Campbellville, Ont.

Table 1.

Mineral Pigments.

Annual Production of Ochres.

Calendar Year.	Tons.	Value.
1886	350	$ 2,350
1887	485	3,733
1888	397	7,900
1889	794	15,280
1890	275	5,125
1891	900	17,750
1892	390	5,800
1893	1,070	17,710
1894	611	8,690
1895	1,339	14,600
1896	2,362	16,045
1897	3,905	23,560
1898	2,226	17,450
1899	3,919	20,000
1900	1,966	15,398
1901	2,233	16,735
1902	4,955	30,495
1903	6,266	32,760
1904	3,925	24,995
1905	5,105	34,675
1906	6,758	36,125

TABLE 2.

MINERAL PIGMENTS.

IMPORTS OF OCHRES.

Fiscal Year.	Duty.	Pounds.	Value.
1880		571,454	$ 6,544
1881		677,115	8,972
1882		731,526	8,202
1883		898,376	10,375
1884		533,416	6,398
1885		1,119,177	12,782
1886		1,100,243	12,267
1887		1,460,128	17,067
1888		1,725,460	17,664
1889		1,342,783	12,994
1890		1,394,811	14,066
1891		1,528,696	20,550
1892		1,708,645	22,908
1893		1,968,645	23,134
1894		1,358,326	18,951
1895		793,258	12,048
1896		1,159,494	16,954
1897		1,504,044	18,504
1898		2,126,592	26,307
1899		2,444,698	31,092
1900		2,474,537	32,017
1901		2,092,067	27,267
1902		2,530,743	33,909
1903		3,215,346	42,243
1904		2,767,580	36,636
1905		3,122,690	35,887
1906 Ochres and ochrey earths and raw siennas	20 p. c.	1,762,682	$ 23,790
1906 Oxides, dry fillers, fire-proofs, umbers and burnt siennas N.E.S.	25 "	2,558,848	33,607
Total, 1906	....	4,321,530	$57,397

TABLE 3.

MINERAL PIGMENTS.

EXPORTS OF MINERAL PIGMENTS, IRON OXIDES ETC.

Calendar Year.	Tons.	Value.
1897	512	$7,706
1898	283	4,227
1899	308	5,408
1900	651	7,154
1901	401	8,233
1902	352	6,182
1903	676	12,770
1904	416	7,260
1905	353	7,704
1906	139	2,379

BARYTES.

The mining of barytes was continued during 1906 by the Ainslie Mining and Railway Company of Halifax at their property at Lake Ainslie, C.B. Total shipments in 1906 were 4,000 tons valued at the mine at $12,000.

The barytes deposits at Five Islands, Colchester county, Nova Scotia, were being reopened and developed by Messrs. Bayne and Soley Bros., who expected to be able to make shipments in 1907.

TABLE 4.

MINERAL PIGMENTS.

ANNUAL PRODUCTION OF BARYTES.

Calendar Year.	Tons.	Value.
1885	300	$ 1,500
1886	3,864	19,270
1887	400	2,400
1888	1,100	3,850
1889	....	....
1890	1,842	7,543
1891	....	....
1892	315	1,260
1893	....	....
1894	1,081	2,830
1895	....	....
1896	145	715
1897	571	3,060
1898	1,125	5,533
1899	720	4,402
1900	1,337	7,605
1901	653	3,842
1902	1,096	3,957
1903	1,163	3,931
1904	1,382	3,702
1905	3,360	7,500
1906	4,000	12,000

TABLE 5.

MINERAL PIGMENTS.

IMPORTS OF BARYTES.

Fiscal Year.	Cwt.	Value.
1880	2,230	$ 1,525
1881	3,740	1,011
1882	497	303
1883	....	185
1884	....	229
1885	7	14
1886	....	62
1887	379	676
1888	236	214
1889	1,332	987
1890	1,322	978

TABLE 6.

MINERAL PIGMENTS.

MISCELLANEOUS IMPORTS, FISCAL YEAR, 1906.

—		Duty.	Quantity.	Value.
				$
Paints and colours, rough stuff and fillers, anti-corrosive and anti-fouling paints commonly used for ship hulls, N.E.S	Lbs.	25 p. c.	4,732,911	275,703
Paris green, dry	"	10 "	156,748	34,658
Paints and colours ground in spirits, and all spirit varnishes and lacquers	Gals.	$1.12½ per gallon	849	2,765
Putty	Lbs.	20 p. c.	246,980	3,862
Total				316,988

MINERAL WATERS.

As has been stated in previous reports the following figures of production of mineral waters must be taken more or less as approximations. At a number of places in Canada where mineral springs occur, the waters are being used for drinking or bathing, and are also bottled and sold in considerable quantity. At several points hotels have been erected near springs, the waters of which are claimed to have curative properties. No data are available of the quantities thus used locally. It is, therefore, very difficult to obtain returns which would enable accurate statistics of the industry to be compiled.

Table 1.

Mineral Waters.

Annual Production.

Calendar Year.	Gallons.	Value.	Calendar Year.	Gallons.	Value.
1888	124,850	$11,456	1898	555,000	$100,000
1889	424,600	37,360	1899	....	100,000
1890	561,165	66,031	1900	....	75,000
1891	427,485	54,268	1901	....	100,000
1892	640,380	75,348	1902	....	100,000
1893	725,096	108,347	1903	....	100,000
1894	767,460	110,040	1904	....	100,000
1895	739,382	126,048	1905	....	100,000
1896	706,372	111,736	1906	....	100,000
1897	749,691	141,477			

TABLE 2.

MINERAL WATERS.

IMPORTS.

Fiscal Year.	Value.
1880	$41,797
1881	55,763
1882	57,953
1883	49,546
1884	48,613
1885	55,864
1886	47,006
1887	52,989
1888	54,891
1889	66,331
1890	71,521
1891	15,721
1892	17,913
1893	27,909
1894	28,130
1895	27,879
1896	32,674
1897	22,142
1898	33,314
1899	38,046
1900	30,343
1901	40,802
1902	91,871
1903	108,130
1904	137,304
1005	161,790
1906 { Mineral waters, natural, not in bottle .... Duty free..	$ 1,754
1906 { Mineral and aerated waters .... " 20 p. c.	176,885
Total	$178,639

NATURAL GAS.

Natural gas is commercially utilized in Canada in the southern peninsula of the Province of Ontario, and at the town of Medicine Hat, Alberta. The total sales in 1906 show a considerable enlargement over the sales in 1905, due chiefly to the development of the Haldimand County field in Ontario The total value of the sales of gas in 1906 was returned as $583,523, as compared with a value of $379,561 in 1905, an increase of $203,962 or 53·7 p. c. Of the total sales in 1906 gas to the value of $532,823 was produced in Ontario, and $50,700 is the estimated value of the gas produced and utilized at Medicine Hat.

The number of wells supplying gas during 1906 is returned as 357 in Ontario, and 7 in Alberta. Companies making returns of gas production report 102 producing wells and 16 non-producing wells bored during the year.

Statistics of the value of the annual production of natural gas are shown in the following table :—

Table 1.

Natural Gas.

Annual Production.

Calendar Year.	Value.
1892	$ 150,000
1893	376,233
1894	313,754
1895	423,032
1896	276,301
1897	325,873
1898	322,123
1899	387,271
1900	417,094
1901	339,476
1902	195,992
1903	202,210
1904	328,376
1905	379,561
1906	583,523

PETROLEUM.

The production of crude petroleum in Canada is still confined to the Province of Ontario ; the exploration of other oil fields, notably in southern Alberta and British Columbia, on Manitoulin island, Ontario, in New Brunswick and in Gaspé, Quebec, not having yet resulted in any important commercial development.

During the session of 1904 of the Dominion Parliament an act was passed providing for the payment of a bounty of one and a half cents per gallon on all crude petroleum produced from wells in Canada. As the quantity of oil on which bounty has been paid during the year will probably represent most closely the actual output, this figure has been taken as the production during the past two years.

On this basis then the production of crude oil during 1906 was 19,941,357 gallons (569,753 barrels), as compared with 22,193,336 gallons (634,095 barrels) in 1905, showing a falling off of 64,342 barrels or 10 p. c. The average monthly price per barrel was almost the same in 1906 as in 1905.

The record of production in former years was obtained in other ways ; for the years 1901 to 1904 inclusive, the production is based on the receipts of Canadian crude oil at refineries to which was added an estimate of the quantity sold directly for fuel and other purposes ; for the years previous to 1901 the production of crude oil was obtained from government inspection returns, by assuming a ratio of crude to refined, and the statistics of production on this basis will be found in table 2.

The annual production of crude oil since 1901, showing the quantity, value and average value per barrel is given in table 1 following :—

Table 1.

Further details of production during the past six years are as follows :—

Crude Oil.	1901.	1902.	1903.	1904.
	Bls.	Bls.	Bls.	Bls.
Received at refineries.....	508,677	443,333	410,280	455,074
Direct sales for industrial purposes..........	113,715	87,291	76,357	48,400
Total sales of crude oil	622,392	530,624	486,637	503,474
Total sales in gallons....	21,783,720	18,571,840	17,032,295	17,621,590

Production calculated on the basis of the bounty of 1½c. per gallon paid by the Dominion Government.	1905.	1906.
Bounty paid........	$332,900	$299,120
Production of crude oil represented. ..	22,193,336 gals.	19,941,357 gals.
Production of crude in barrels.......	634,095 bls.	569,753 bls.

The following tables illustrate the petroleum industry of Canada by giving the exports, imports, returns of inspection and other data :—

TABLE 1.

PETROLEUM.

ANNUAL PRODUCTION OF CRUDE PETROLEUM SINCE 1901.

Year.	Barrels of 35 gallons.	Value.	Average price per barrel.
1901..	622,392	$1,008,275	$1.62
1902...	530,624	951,190	1.79¼
1903..........	486,637	1,048,974	2.15½
1904.,.	503,474	935,895	1 858
1905...	634,095	856,028	1.35
1906.......	569,753	761,760	1.337

TABLE 2.

PETROLEUM.

CANADIAN OILS AND NAPHTHA INSPECTED, AND CORRESPONDING QUANTITIES OF CRUDE OIL.

Calendar Year.	Refined Oils Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.	Equivalent in Barrels of 35 Gallons.	Average Price per Barrel of Crude.	Value of Crude Oil.
	Gallons.	Gallons.				
1881..... .	6,457,270	12,914,540	100:50	368,987	....	....
1882.	6,135,782	13,635,071	100:45	389,573	....	... .
1883.	7,447,648	16,550,328	100:45	472,866	....	....
1884......	7,993,995	19,984.987	100:40	571,000	....	....
1885.......	8,225,882	20,564,705	100:40	587,563	....	....
1886......	7,768,006	20,442,121	100:38	584,061	$0 90	$525,655
1887......	9,492,588	24,980,494	100:38	713,728	0 78	556,708
1888.... .	9,246,176	24,332,042	100:38	695,203	1 02⅔	713,695
1889...	9,472,476	24,664,144	100:38	704,690	0 92¾	653,600
1890.. . ..	10,174,894	26,776,037	100:38	795,030	1 18	902,734
1891.	10,065,463	26,435,430	100:38	755,298	1 33¾	1,010,211
1892. . ..	10,370,707	27,291,334	100:38	779,753	1 26¼	984,438
1893......	10,618,804	27,944,221	100:38	798,406	1 09½	874,255
1894.	11,027,082	29,018,637	100:38	829,104	1 00¾	835,322
1895.	10,674,232	25,414,838	100:42	726,138	1 49⅔	1,086,738
1896.......	10,681,284	25,438,771	100:42	726,822	1 59	1,155,647
1897.......	10,434,878	24,844,995	100:42	709,857	1 42½	1,011,546
1898.. . .	11,148,348	26,543,685	100:42	758,391	1 40	1,061,747
1899..... .	11,927,981	28,399,955	100:42	808,570	1 48⅔	1,202,020
1900.......	13,428,422	24,867,449	100:54	710,498	1 62	1,151,007

TABLE 3.

PETROLEUM.

VALUE OF THE PRODUCTION OF CANADIAN OIL REFINERIES.

Calendar Year.	Value.	Calendar Year.	Value.
1887	$1,288,109	1897	$1,672,429
1888	1,401,459	1898	1,825,265
1889	1,414,184	1899	1,490,870
1890	1,638,420	1900	1,620,705
1891	1,534,509	1901	1,251,373
1892	1,782,365	1902	1,222,641
1893	1,675,784	1903	1,302,104
1894	1,567,134	1904	975,840
1895	1,806,237	1905	(a) 1,815,525
1896	1,876,913	1906	(a) 2,120,343

(*a*) Derived from both Canadian and imported crude oils.

TABLE 4.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Fiscal Year.	Canadian.	Imported.	Total.	Canadian.	Imported.
	Gallons.	Gallons.	Gallons.	Per cent.	Per cent.
1881	6,406,783	476,784	6,883,567	93.1	6·9
1882	5,910,747	1,351,412	7,262,159	81·4	18·6
1883	6,970,550	1,190,828	8,161,378	85·4	14·6
1884	7,656,001	1,142,575	8,798,586	87·0	13·0
1885	7,661,617	1,278,115	8,939,732	85·7	14·3
1886	8,149,472	1,327,616	9,477,088	86·0	14·0
1887	8,243,962	1,665,604	9,909,566	83·2	16·8
1888	9,545,895	1,821,342	11,367,237	84·0	16·0
1889	9,462,834	1,767,812	11,230,646	84·3	15·7
1890	10,121,210	2,020,742	12,141,952	83·4	16·6
1891	10,270,107	2,022,002	12,292,109	83·6	16·4
1892	10,238,426	2,429,445	12,667,871	80·8	19·2
1893	10,683,806	2,641,690	13,325,496	80·2	19·8
1894	10,824,270	5,633,222	16,457,492	65·8	34·2
1895	10,936,992	5,650,994	16,587,986	65·9	34·1
1896	10,533,951	5,807,991	16,341,942	64·5	35·5
1897	10,506,526	6,248,743	16,755,269	62·7	37·3
1898	10,796,847	6,880,734	17,677,581	61·1	38·9
1899	11,005,804	7,232,348	18,238,152	60·3	39·7
1900	13,014,713	*8,216,207	21,230,920	61·3	38·7
1901	12,674,977	*9,232,165	21,907,142	57·9	42·1
1902	10,494,874	*10,916,396	21,411,270	49·0	51·0
1903	8,615,892	*14,479,176	23,095,068	37·3	62·7
1904	7,292,113	*17,369,930	24,662,043	29·6	70·4
1905	17,520,035	*10,284,053	27,804,088	63.0	37.0
1906	18,634,155	*9,255,200	27,889,355	66·8	33 2

* Item (*a*) table 5.

TABLE 5.

PETROLEUM.

EXPORTS OF CRUDE AND REFINED PETROLEUM.

Calendar Year.	Crude Oil.		Refined Oil.		Total.	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
1881	....	....	....	....	501	$ 99
1882	....	.. ..	....	....	1,119	286
1883	... .	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$ 18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067
1896	601	101	7,489	999	8,090	1,100
1897	....	....	342	49	342	49
1898	96	4	12,735	3,001	12,831	3,005
1899	....	....	3,425	859	3,425	859
1900	40	2	8,559	394	8,599	2,396
1901	14,168	691	375	66	14,543	757
1902	400	40	626	146	1,026	186
1903	350	15	1,013	190	1,363	205
1904	4,207	213	2,126	470	6,333	683
1905	35	2	7,228	2,078	7,263	2,080
1906	900	141	8,938	1,401	9,838	1,542

TABLE 6.

PETROLEUM.

IMPORTS OF PETROLEUM AND PRODUCTS OF.

Fiscal Year.	Gallons.	Value.
		$
1880	687,641	131,359
1881	1,437,475	262,168
1882	3,007,702	398,031
1883	3,086,316	358,546
1884	3,160,282	380,082
1885	3,767,441	415,195
1886	3,819,146	421,836
1887	4,290,003	467,003
1888	4,523,056	408,025
1889	4,650,274	484,462
1890	5,075,650	515,852
1891	5,071,386	498,330
1892	5,649,145	475,732
1893	6,002,141	446,389
1894	6,597,108	439,988
1895	7,577,674	525,372
1896	8,005,891	735,913
1897	8,415,302	697,169
1898	9,074,311	724,519
1899	10,394,208	763,303
1900	9,633,647	864,833
1901	11,082,822	982,640
1902	13,220,005	1,107,207
1903	18,799,312	1,643,371
1904	24,521,115	2,152,623
1905	35,296,332	2,151,514

		Duty.	Gallons.	Value.
1906	Oils :—			
	Mineral :			$
	(*a*) Coal and kerosene, distilled, purified or refined, naphtha and petroleum. N.E.S	2½c. p. gal.	9,255,200	812,226
	(*b*) Products of petroleum	2½c. "	1,633,309	177,069
	(*c*) Crude petroleum, gas oils (other than benzine or gasoline)	1½c. "	19,680	1,282
	Petroleum crude, fuel and gas oils (8233 specific gravity)	Free.	19,805,656	667,172
	(*d*) Illuminating oils composed wholly or in part of the products of petroleum, coal, shale or lignite, costing more than 30 cents per gallon	20 p. c.	3,536	1,490
	(*e*) Lubricating oils composed wholly or in part of petroleum, costing less than 25 cents per gallon	2½c. p. gal.	1,907,029	248,938
	Total		32,624,410	1,908,177

TABLE 7.*

PETROLEUM.

IMPORTS OF CRUDE AND MANUFACTURED OILS, OTHER THAN ILLUMINATING.

Fiscal Year.	Gallons.	Fiscal Year.	Gallons.
1881	960,691	1894	1,860,829
1882	1,656,290	1895	1,106,993
1883	1,895,488	1896	1,079,965
1884	2,017,707	1897	802,286
1885	2,489,326	1898	1,047,026
1886	2,491,530	1899	1,017,278
1887	2,624,399	1900	1,406,700
1888	2,701,714	1901	1,838,966
1889	2,882,462	1902	2,296,353
1890	3,054,908	1903	4,316,010
1891	3,049,384	1904	7,141,109
1892	3,047,199	1905	25,002,047
1893	1,481,749	1906	23,365,674

*The figures for the years from 1881 to 1894, inclusive, represent the total imports of petroleum and products, less the quantity of imported illuminating oils, inspected by the Inland Revenue Department. For 1895 and subsequent years, the table is composed of items (*b*), (*c*) and (*e*) of table 5.

TABLE 8.

PETROLEUM.

IMPORTS OF PARAFFINE WAX.

Fiscal Year.	Pounds.	Value.
1883	43,716	$ 5,166
1884	39,010	6,079
1885	59,967	8,123
1886	62,035	7,953
1887	61,132	6,796
1888	53,862	4,930
1889	63,229	5,250
1890	239,229	15,844
1891	753,854	50,275
1892	733,873	48,776
1893	452,916	38,935
1894	208,099	15,704
1895	163,817	11,579
1896	150,287	10,042
1897	138,703	7,945
1898	103,570	5,987
1899	92,242	4,025
1900	47,400	3,529
1901	118,845	9,639
1902	225,885	12,750
1903	592,642	28,674
1904	418,967	18,440
1905	81,992	7,795
1906 (Duty, 25 p. c.)	112,612	9,721

TABLE 9.

PETROLEUM.

IMPORTS OF PARAFFINE WAX CANDLES.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880.........	10,445	$2,269	1894.........	10,818	$1,685
1881.........	7,494	1,683	1895.........	19,448	2,541
1882.........	5,818	1,428	1896.........	25,787	4,072
1883.........	7,149	1,734	1897.........	25,114	2,929
1884.........	8,755	2,229	1898.........	60,802	4,427
1885.........	9,247	2,449	1899.........	62,331	5,856
1886.........	12,242	2,587	1900.........	27,663	3,671
1887.........	21,364	3,611	1901.........	44,562	3,588
1888.........	22,054	2,829	1902.........	51,120	5,752
1889.........	8,038	1,337	1903.........	83,377	9,025
1890.........	7,233	1,186	1904.........	83,471	9,078
1891.........	10,598	2,116	1905.........	137,353	15,293
1892.........	9,259	1,952	1906 (Duty, 25 p.c.).........	148,808	15,804
1893.........	8,351	1,735			

PHOSPHATE

The phosphate or apatite mined in Canada in recent years has been chiefly obtained as a by-product in the mining of mica, and the quantity has been comparatively small. In 1906 the production is, according to the authority of Mr. J. F. Higginson of Buckingham, estimated at 850 short tons valued at $6,375, of which 600 tons were obtained from mines in the Province of Quebec, and 250 tons from Ontario.

At one time this mineral was mined to the extent of from 20,000 to 30,000 tons a year, but the production was displaced by the more cheaply mined phosphates of Carolina, Florida and Tennessee.

Statistics of production and exports are given in tables 1 and 2.

TABLE 1.

PHOSPHATE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Average value per ton.	Value.
1886	20,495	$14.85	$304,338
1887	23,690	13.50	319,815
1888	22,485	10.77	242,285
1889	30,988	10.21	316,662
1890	31,753	11.37	361,045
1891	23,588	10.24	241,603
1892	11,932	13.20	157,424
1893	8,198	8.65	70,942
1894	6,861	6.00	41,166
1895	1,822	5.25	9,565
1896	570	6.00	3,420
1897	908	4.39	3,984
1898	733	5.00	3,665
1899	3,000	6.00	18,000
1900	1,415	5.02	7,105
1901	1,033	6.07	6,280
1902	856	5.79	4,953
1903	1,329	6.18	8,214
1904	817	5.62	4,590
1905	1,300	6.48	8,425
1906	850	7.50	6,375

TABLE 2.

PHOSPHATE.

EXPORTS.

Calendar Year.	Ontario.		Quebec.		Totals.	
	Tons.	*Value.	Tons.	*Value.	Tons.	*Value.
1878	824	$12,278	9,919	$195,831	10,743	$208,109
1879	1,842	20,565	6,604	101,470	8,446	122,035
1880	1,387	14,422	11,673	175,664	13,060	190,086
1881	2,471	36,117	9,497	182,339	11,968	218,456
1882	568	6,338	16,585	302,019	17,153	308,357
1883	50	500	19,666	427,168	19,716	427,668
1884	763	8,890	20,946	415,350	21,709	424,240
1885	434	5,962	28,535	490,331	28,969	496,293
1886	644	5,816	19,796	337,191	20,460	343,007
1887	705	8,277	22,447	424,940	23,152	433,217
1888	2,643	30,247	16,133	268,362	18,776	298,609
1889	3,547	38,833	26,440	355,935	29,987	394,768
1890	1,866	21,329	26,591	478,040	28,457	499,369
1891	1,551	16,646	15,720	368,015	17,271	384,661
1892	1,501	12,544	9,981	141,221	11,482	153,765
1893	1,990	11,550	5,748	56,402	7,738	67,952
1894	1,980	10,560	3,470	29,610	5,450	40,170
1895	....	....	250	2,500	250	2,500
1896	1	5	299	2,990	300	2,995
1897	70	450	165	400	235	850
1898	21	240	702	8,000	723	8,240
1899	215	1,850	93	1,725	308	3,575
1900	....	....	....	....	Nil	Nil
1901	....	....	....	....	6	120
1902	....	....	....	....	70	1,880
1903	....	....	....	....	1	20
1904	....	....	....	....	191	5,348
1905	....	....	....	....	40	1,253
1906	....	....	....	....	....	....

* These values do not compare with those in table 1 above ; the spot value is adopted for the production, whilst the exports are valued upon quite a different basis.

PYRITES.

Copper pyrites has been mined for many years in the Province of Quebec, at Capelton and Eustis, by the Nichols Chemical Co., and the Eustis Mining Co. A portion of this ore is used at Capelton in the manufacture of sulphuric acid, and the balance exported. The production in 1906 was 32,348 tons valued at $129,392.

In Ontario, iron pyrites was mined by the American Madoc Mining Co., at Bannockburn and Tweed; by the British American Development Company near Queensboro; by the Lake Superior Power Co., at the Helen mine, Michipicoten; and by the North Land Mining Co., at Rib lake, on the Temiskaming and Northern Ontario railway.

The shipments were 10,395 tons valued at $40,598. The total production of pyrites was, therefore, 42,743 tons valued at $169,990, as compared with 33,339 tons valued at $125,486 in 1905.

The exports of pyrites during 1906 were, according to Customs returns 26,050 tons valued at $65,349.

Statistics of the production of pyrites, and of the imports of brimstone and sulphur, are given in tables 1 and 2.

TABLE 1.

PYRITES.

ANNUAL PRODUCTION.

Calendar Year.	Tons, 2,000 lbs.	Value.
		$
1886	42,906	193,077
1887	38,043	171,194
1888	63,479	285,656
1889	72,225	307,292
1890	49,227	123,067
1891	67,731	203,193
1892	59,770	179,310
1893	58,542	175,626
1894	40,527	121,581
1895	34,198	102,594
1896	33,715	101,155
1897	38,910	116,730
1898	32,218	128,872
1899	27,687	110,748
1900	40,031	155,164
1901	35,261	130,544
1902	35,616	138,939
1903	33,982	127,713
1904	37,180	134,033
1905	33,339	125,486
1906	42,743	169,990

TABLE 2.

PYRITES.

IMPORTS:—BRIMSTONE AND CRUDE SULPHUR.

Fiscal Year.	Pounds.	Value.
		$
1880	1,775,489	27,401
1881	2,118,720	33,956
1882	2,375,821	40,329
1883	2,336,085	36,737
1884	2,195,735	37,463
1885	2,248,986	35,043
1886	2,922,043	43,651
1887	3,103,644	38,750
1888	2,048,812	25,318
1889	2,427,510	34,006
1890	4,440,799	44,276
1891	3,601,748	46,351
1892	4,769,759	67,095
1893	6,381,203	77,216
1894	5,845,463	61,558
1895	4,900,225	56,965
1896	6,934,190	63,973
1897	8,672,751	87,719
1898	38,026,798	373,786
1899	24,517,026	265,799
1900	21,128,656	215,433
1901	23,856,651	270,608
1902	24,640,735	325,307
1903	24,412,737	259,123
1904	19,364,730	204,663
1905	23,435,140	242,251
1906*	43,047,672	436,156

* Brimstone, crude, or in roll or flour, and sulphur in roll or flour.

SALT.

Salt production in Canada in 1906 was entirely from the Province of Ontario from the deposits in the counties of Essex, Lambton, Middlesex, Huron and Bruce. Returns from thirteen plants showed the total sales of salt as 76,762 tons valued at $329,130, exclusive of packages which were valued at $147,705. The stock on hand in manufacturers' hands at the end of the year was 6,365 tons. There were 210 men employed for various periods during the year, to whom $92,000 was paid in wages.

In 1905 the sales were 67,340 tons valued at $320,858, and the value of packages used was $113,004. The Canadian Salt Company of Windsor is the chief operator, producing nearly 50 p. c. of the total output. The system of evaporation used by this firm is the compound double effect vacuum.

In 1896 a few tons of salt were produced at the south end of Lake Winnipegosis, Manitoba, but the industry has not been followed up in this district. Small quantities of brine have occasionally been evaporated at Plumweseep, New Brunswick, and sold locally along the line of the Intercolonial railway. These works have now been taken over by Wm. Harvie of London, England, and preparations are being made to renew the production of salt in this locality.

Annual statistics of salt production are shown in table 1. The exports of salt, which are of small amount, are shown in table 2. Tables 3 and 4 show the quantities and values of the salt imported. The value of salt imported on which duty is levied has ranged from $20,000 to $80,000 a year, the value in 1906 being $59,805.

Salt imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries, is free of duty, and a large portion of the trade of Eastern Canada is supplied with salt imported under this class. The quantity imported duty free in 1906 was 101,540 tons valued at $352,214.

TABLE 1.
SALT.
ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.
1886	62,359	$227,195
1887	60,173	166,394
1888	59,070	185,460
1889	32,832	129,547
1890	43,754	198,857
1891	45,021	161,179
1892	45,486	162,041
1893	62,324	195,926
1894	57,199	170,687
1895	52,376	160,455
1896	43,960	169,693
1897	51,348	225,730
1898	57,142	248,639
1899	59,339	254,390
1900	62,055	279,458
1901	59,428	262,328
1902	64,456	292,581
1903	62,452	297,517
1904	69,477	321,778
1905	67,340	320,858
1906	76,720	329,130

TABLE 2.
SALT.
EXPORTS.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959
1896	3,842	899
1897	5,383	1,193
1898	5,202	1,252
1899	11,205	2,773
1900	37,653	8,997
1901	39,224	6,510
1902	9,331	3,798
	Pounds.	
1903	1,915,648	5,927
1904	1,006,036	4,186
1905	1,447,728	6,112
1906	618,707	3,437

TABLE 3.

SALT.

IMPORTS :—SALT PAYING DUTY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	726,640	$ 3,916	1893	21,377,339	$79,838
1881	2,588,465	6,355	1894	15,867,825	53,336
1882	3,679,415	12,318	1895	8,498,404	29,881
1883	12,136,968	36,223	1896	7,665,257	24,550
1884	12,770,950	38,949	1897	11,911,766	33,470
1885	10,397,761	31,726	1898	11,068,785	32,792
1886	12,266,021	39,181	1899	11,781,453	32,839
1887	10,413,258	35,670	1900	11,028,337	30,180
1888	10,509,799	32,136	1901	11,625,688	34,087
1889	11,190,088	38,968	1902	13,892,849	39,605
1890	15,135,109	57,549	1903	14,554,693	41,785
1891	15,140,827	59,311	1904	29,779,183	73,826
1892	18,643,191	65,963	1905	18,473,868	58,056

		Duty.	Pounds.	Value.
1906	Salt, coarse, N.E.S	5c. per 100 lbs.	14,900,108	33,627
	Salt, fine, in bulk	5c. "	2,797,950	7,983
	Salt, N. E. S., in bags, barrels or other packages	$7\frac{1}{2}$c. "	3,668,006	18,195
	Total		21,366,064	59,805

TABLE 4.

SALT.

IMPORTS :—SALT NOT PAYING DUTY.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	212,714,747	$400,167	1893	191,595,530	281,462
1881	231,640,610	488,278	1894	196,668,730	328,300
1882	166,183,962	311,489	1895	201,691,248	332,711
1883	246,747,113	386,144	1896	205,005,100	338,888
1884	225,390,121	321,243	1897	215,844,484	312,117
1885	171,571,209	255,719	1898	202,634,927	293,410
1886	180,205,949	255,359	1899	183,046,365	267,520
1887	203,042,332	285,455	1900	193,554,550	295,253
1888	184,166,986	220,975	1901	216,271,603	339,887
1889	180,847,800	253,009	1902	238,648,737	385,629
1890	158,490,075	252,291	1903	232,708,675	361,185
1891	195,491,410	321,239	1904*	198,634,047	338,082
1892	201,831,217	314,995	1905*	196,907,500	340,954
			1906*	203,080,000	352,214

*Salt imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries.

Following is a list of salt producers :—

The Canadian Salt Co., Ltd.	Windsor, Ont.
The Saginaw Lumber and Salt Co.	Sandwich, Ont.
The Western Salt Co., Ltd.	Mooretown, Ont.
Carter & Kittermaster	Sarnia, Ont.
Empire Salt Co.	"
Sarnia Salt Co.	"
Sarnia Bay Lumber, Timber and Salt Co.	"
Elarton Salt Works Co., Ltd.	Warwick, Ont.
Parkhill Salt Co.	Parkhill, Ont.
Exeter Salt Works Co.	Exeter, Ont.
Hensall Salt Works	Hensall, Ont.
Western Canada Flour Mills Co., Ltd	Goderich, Ont.
R. & J. Ransford	Clinton, Ont.
Stapelton Salt Works	Clinton, Ont.
Brussels Salt Works	Brussels, Ont.
Gray, Young & Sparling Co. of Ont., Ltd.	Wingham, Ont.
Ontario People's Salt and Soda Co.	Kincardine, Ont.
Wm. Harvie, London, Eng.	(H. D. Buchanan, Plumweseep, N.B.)

MISCELLANEOUS NON-METALLIC.

ARSENIC.

Up to 1903 the main source of the production of arsenic in Canada was the Deloro mine in Hastings county, Ontario. The arsenic was recovered at Deloro in the process of treating the auriferous mispickel ores found in the district. In 1902, however, the mine was closed, though the mill continued to work on tailings and ore from the dump until 1903, when operations ceased altogether. This property has recently been taken over by the Deloro Mining and Reduction Company, and the plant entirely rebuilt, with the object of treating ores from Cobalt district as well as the local mispickel ores. There was no production of white arsenic at the plant, however, during 1906.

The ores shipped from the Cobalt district contain important quantities of arsenic, though only a small portion of it is paid for by the purchasing companies. The quantity of arsenic contained in these ores shipped during the past three years has been, according to information collected by the Ontario Bureau of Mines, 72 tons in 1904 ; 549 tons in 1905 ; and 1440 tons in 1906 (see table 1). The values as given in the table represent only the quantities paid for.

A plant for the reduction of the Cobalt District ores, and equipped to save the arsenic, has been erected at Copper Cliff, Ontario, by the Canadian Copper Company, the quantity of white arsenic produced during 1906 being 201 tons valued at $14,058.

TABLE 1.
MISCELLANEOUS—NON-METALLIC.
ANNUAL PRODUCTION OF ARSENIC.

Calendar Year.	Arsenic in Ore.		White Arsenic.	
	Tons.	Value.	Tons.	Value.
1885			440	$17,600
1886			120	5,460
1887			30	1,200
1888			30	1,200
1889			Nil.	Nil.
1890			25	1,500
1891			20	1,000
1892			Nil.	Nil.
1893			"	"
1894			7	420
1895			Nil.	Nil.
1896			"	"
1897			"	"
1898			"	"
1899			57	4,872
1900			303	22,725
1901			695	41,676
1902			800	48,000
1903			257	15,420
1904	72	$ 903	.....	....
1905	549	2,692	.....	.....
1906	1,440	15,858	201	14,058

TABLE 2.
MISCELLANEOUS.—NON-METALLIC.
IMPORTS OF ARSENIC.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576	1894	292,505	10,018
1881	31,417	1,070	1895	1,115,697	31,932
1882	138,920	3,962	1896	664,854	27,523
1883	51,953	1,812	1897	152,275	8,378
1884	19.337	773	1898	291,967	14,270
1885	49,080	1,566	1899	582,383	24,203
1886	30,181	961	1900	230,730	11,035
1887	32,436	1,116	1901	159,263	8,361
1888	27,510	1,016	1902	106,857	6,004
1889	69,269	2,434	1903	298,375	11,824
1890	138,509	4,474	1904	414,065	12,421
1891	115,248	4,027	1905	268,274	7,661
1892	302,958	9,365	1906 Duty Free.	446,975	19,169
1893	447,079	$12,907			

CHALK AND WHITING.

These materials are not produced in Canada, but statistics of their importation are given to show the market for them in Canada.

TABLE 3.
MISCELLANEOUS.—NON-METALLIC.
IMPORTS OF CHALK.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$2,117	1894	$ 11,308
1881	2,768	1895	7,730
1882	2,882	1896	6,467
1883	5,067	1897	7,432
1884	2,589	1898	9,338
1885	8,003	1899	10,461
1886	6,583	1900	12,212
1887	5,635	1901	11,629
1888	5,865	1902	11,337
1889	5,336	1903	16,497
1890	7,221	1904	19,163
1891	8,193	1905	20,896
1892	9,558	1906*	23,853
1893	9,966		

* Chalk prepared. Duty, 20 p.c.

TABLE 4.

MISCELLANEOUS.—NON-METALLIC.

IMPORTS OF WHITING.

Fiscal Year.	Cwt.	Value.	Fiscal Year.	Cwt.	Value.
1880.........	84,115	$26,092	1894........	103,633	$26,649
1881.........	47,480	16,637	1895.........	102,751	25,441
1882.........	36,270	16,318	1896.........	113,791	27,322
1883.........	76,012	29,334	1897.........	102,453	22,541
1884.........	76,268	28,230	1898.........	166,293	25,761
1885.........	67,441	23,492	1899.........	134,884	34,310
1886.........	65,124	25,533	1900.........	127,455	34,575
1887.........	47,246	15,191	1901.........	209,868	60,878
1888........	76,619	20,508	1902.........	153,982	42,136
1889.........	84,658	22,735	1903........	139,804	39,867
1890.........	96,243	27,471	1904........	186,919	42,507
1891........	84,679	27,504	1905.........	198,485	51,215
1892.........	102,985	26,867	1906*........	160,030	44,876
1893.........	88,835	25,563			

* Whiting or whitening, gilder's whiting, and Paris white. Duty free.

FELDSPAR.

There was a small production of feldspar from the township of Templeton, Que., the main part of the shipments, however, coming from the townships of Bedford and Portland, Frontenac county, Ontarîo.

Two companies furnishing statements of shipments in Ontario were the Kingston Feldspar and Mining Co., and the Verona Mining Company. The total shipments, according to returns received, were 16,948 tons valued at $40,890.

The production at Templeton was used at Buckingham, Que., while the shipments from Ontario were all exported to the United States.

According to Customs returns the exports during 1906 were 18,183 tons valued at $60,312.

TABLE 5.
MISCELLANEOUS—NON-METALLIC.
PRODUCTION OF FELDSPAR.

Calendar Year.	Tons.	Value.
1890	700	$3,500
1891	685	3,425
1892	175	525
1893	575	4,525
1894	Nil.	Nil.
1895	..	*2,545
1896	972	*2,583
1897	1,400	3,290
1898	2,500	6,250
1899	3,000	6,000
1900	318	1,112
1901	5,350	10,700
1902	7,576	15,152
1903	13,928	18,966
1904	11,083	22,166
1905	11,700	23,400
1906	16,948	40,890

* Exports.

FIRE-CLAY.

Returns of fire-clay production in 1906 show a total output of 6,559 tons valued at $18,522, which was derived mainly from the clays found with the coal measures at Westville, N. S., and Comox, B.C. Part of the production at Westville was made into fire bricks which were sold at Sydney and local points, while the output at Comox was shipped to the Columbia Clay Company at Victoria and used in the manufacture of pottery and sewer pipe.

TABLE 6.
MISCELLANEOUS—NON-METALLIC.
PRODUCTION OF FIRE-CLAY.

Calendar Year.	Tons.	Value.
1889	400	$4,800
1890	Nil.	Nil.
1891	250	750
1892	1,991	4,467
1893	540	700
1894	539	2,167
1895	1,329	3,492
1896	842	1,805
1897	2,118	5,759
1898	670	1,680
1899	599	1,295
1900	1,245	4,130
1901	3,979	5,920
1902	2,741	4,283
1093	2,639	3,523
1904	5,972	17,463
1905	5,088	13,917
1906	6,559	18,522

MOULDING SAND.

The figures of production of moulding sand as given in table 7 were derived chiefly from the returns of railway shipments from points in Southern Ontario, together with a small production in Nova Scotia, and do not nearly represent the total production. The publication of the incomplete returns has, therefore, been discontinued for the present.

TABLE 7.

MISCELLANEOUS—NON-METALLIC.

PRODUCTION OF MOULDING SAND.

Calendar Year.	Tons.	Value.
1887	160	$ 800
1888	169	845
1889	170	850
1890	320	1,410
1891	230	1,000
1892	345	1,380
1893	4,370	9,086
1894	6,214	12,428
1895	6,765	13,530
1896	5,739	11,478
1897	5,485	10,931
1898	10,572	21,038
1899	13,724	27,430
1900	6,181	12,316
1901	14,705	29,410
1902	13,352	27,651
1903	3,658	7,256
1904	3,423	6,790
1905	*	*
1906	*	*

* Returns incomplete.

QUARTZ.

The production of quartz as reported to the Ontario Bureau of Mines for 1906 was 48,376 tons valued at $65,765. This was mined by the Canadian Copper Company, and Algoma Commercial Company, and used principally as a flux and for converter linings.

TABLE 8.

MISCELLANEOUS—NON-METALLIC.

ANNUAL PRODUCTION OF QUARTZ.

Calendar Year.	Tons.	Value.
1890	200	$ 1,000
1891	....	....
1892	....	....
1893	100	500
1894	....	....
1895	....	....
1896	10	50
1897	....	....
1898	284	570
1899	600	1,260
1900-1905	....	....
1906	48,376	65,765

TABLE 9

MISCELLANEOUS—NON-METALLIC.

IMPORTS OF "SILEX"—CRYSTALLIZED QUARTZ.

Fiscal Year.	Cwt.	Value.
1880	5,252	$ 2,290
1881	3,251	1,659
1882	3,283	1,678
1883	3,543	2,058
1884	3,259	1,709
1885	3,527	1,443
1886	2,520	1,313
1887	14,533	5,073
1888	4,808	2,385
1889	5,130	1,211
1890	1,768	2,617
1891	3,674	1,929
1892	1,429	1,244
1893	2,447	1,301
1894	2,451	1,521
1895	2,882	1,881
1896	3,289	2,174
1897	2,564	3,415
1898	3,104	2,773
1899	3,951	2,595
1900	4,021	2,876
1901	3,562	2,106
1902	4,388	3,858
1903	3,514	2,762
1904	5,547	4,409
1905	8,931	4,475
1906 ....Duty Free.	7,465	8,347

TALC.

The production of talc in 1906 was all from the Henderson mine in Huntingdon township, Hastings county, Ontario, and the shipments were 1,234 tons valued at $3,030. The mineral was exported to United States points, and chiefly used in the manufacture of cosmetics.

TABLE 10.

MISCELLANEOUS—NON-METALLIC.

ANNUAL PRODUCTION OF SOAPSTONE AND TALC.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1886	50	$ 400	1897	157	$ 350
1887	100	800	1898	405	1,000
1888	140	280	1899	450	1,960
1889	195	1,170	1900	1,420	6,365
1890	917	1,239	1901	259	842
1891	Nil	Nil	1902	689	1,804
1892	1,374	6,240	1903	990	2,739
1893	717	1,920	1904	840	1,875
1894	916	1,640	1905	500	1,800
1895	475	2,138	1906	1,234	3,030
1896	410	1,230			

STRUCTURAL MATERIALS.

The structural or building materials included under this heading comprise stone such as building stone, granite, marbles, slate, flagstones, etc , cement and lime ; and the manufactures of clay, such as bricks, tiles, drainpipe, earthenware and coarse pottery.

STONE.

Building stone.

Complete information regarding the production of building stone, excluding granite, is not available. In Ontario the production in 1906 of building and crushed stone, as per returns to the Ontario Bureau of Mines, was valued at $660,000. For the other provinces the information is incomplete, but a rough estimate would place the total production in Canada at about $1,830,000.

Statistics of the production of building stone are shown in table 1, the exports and imports of stone in tables 2, 3, and 4.

TABLE 1.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF BUILDING STONE.

Calendar Year.	Value.
1886	$ 642,509
1887	552,267
1888	641,712
1889	913,691
1890	964,783
1891	708,736
1892	609,827
1893	1,100,000
1894	1,200,000
1895	1,095,000
1896	1,000,000
1897	1,000,000
1898	1,300,000
1899	1,500,000
1900	1,520,000
1901	1,650,000
1902	1,900,000
1903	1,975,000
1904	1,930,000
1905	1,830,000
1906	1,830,000

TABLE 2.

STRUCTURAL MATERIALS.

EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

Calendar Year.	Wrought.	Unwrought.
1890	$ 21,725	$ 43,611
1891	13,398	46,162
1892	7,698	47,424
1893	9,102	12,532
1894	22,576	34,130
1895	8,587	51,616
1896	4,934	32,897
1897	9,415	42,034
1898	2,526	65,370
1899	5,092	101,931
1900	5,933	115,711
1901	5,917	157,739
1902	8,632	124,829
1903	7,684	46,295
1904	4,760	17,802
1905	3,545	13,089
1906	23,097	4,675

TABLE 3.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING STONE.

Calendar Year.	Value.	Calendar Year.	Value.
1880	$ 35,970	1893	$56,510
1881	58,149	1894	52,908
1882	33,623	1895	44,282
1883	35,061	1896	54,130
1884	51,088	1897	38,714
1885	30,491	1898	28,495
1886	41,675	1899	48,040
1887	54,368	1900	64,533
1888	86,373	1901	46,078
1889	100,314	1902	99,074
1890	132,155	1903	87,866
1891	170,890	1904	93,778
1892	95,550	1905	102,817

1906	Flagstones, granite and rough freestone, sandstone, and all building stone, not hammered or chiselled. Duty 15 p. c.	$66,994
	Granite and freestones, dressed; all other building stone dressed, except marble. Duty 20 p. c.	65,134
	Total	$132,128

TABLE 4.

STRUCTURAL MATERIALS.

IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$29,408	1893	$49,323
1881	36,877	1894	49,510
1882	37,267	1895	51,050
1883	45,636	1896	51,499
1884	45,290	1897	34,026
1885	39,867	1898	41,240
1886	41,984	1899	60,148
1887	41,829	1900	57,039
1888	47,487	1901	66,639
1889	61,341	1902	72,397
1890	84,396	1903	78,629
1891	61,051	1904	141,165
1892	39,479	1905	150,160

			Value
1906	Granite—Sawn only	Duty, 20 p.c.	$32,316
	" Finished and polished	" 35 p.c.	....
	" Manufactures of N.O.P	" 35 p.c.	94,717
	Paving blocks	" 20 p.c.	24,817
	Manufactures of stone, N.O.P	" 30 p.c.	26,585
			$178,435

MARBLE.

There has been no production of marble reported since 1896. During the past year a small quantity of sodalite, a beautiful decorative stone, was shipped from the quarries at Bancroft being opened up by the Princess Quarries Company.

Statistics of the production of marble in former years are shown in table 5, and imports of marble in table 6.

TABLE 5.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF MARBLE.

Calendar Year.	Tons.	Value.
1886	501	$9,900
1887	242	6,224
1888	191	3,100
1889	83	980
1890	780	10,776
1891	240	1,752
1892	340	3,600
1893	590	5,100
1894	Nil.	Ni
1895	200	2,000
1896	224	2,405
1897 to 1906, inclusive	Nil.	Nil.

TABLE 6.

STRUCTURAL MATERIALS.

IMPORTS OF MARBLE.

Fiscal Year.	Value.
1880	$ 63,015
1881	85,977
1882	109,505
1883	128,520
1884	108,771
1885	102,835
1886	117,752
1887	104,250
1888	94,681
1889	118,421
1890	99,353
1891	107,661
1892	106,268
1893	96,177
1894	94,657
1895	83,422
1896	90,065
1897	77,150
1898	95,894
1899	101,879
1900	94,017
1901	96,159
1902	130,424
1903	153,481
1904	181.511
1905	145,466

		Duty.	
1906	Marble and manufactures of :—		
	Marble sawn only	20 %	$108,718
	Finished and polished	35 %	....
	Rough, not hammered or chiselled	15 %	6,827
	Manufactures of, N.O.P	35 %	74,044
	Total, marble and manufactures of	......	$189,589

GRANITE.

Granite, both for monumental and building purposes, was quarried as usual in Nova Scotia, New Brunswick, Quebec, and British Columbia.

In Nova Scotia the industry was confined to the vicinities of Halifax and Middleton, while in New Brunswick the granite industries at St. George and at Hampstead were carried on with about the same success as in immediately preceding years.

The chief sources of the granite production of Quebec in 1906 were in Chatham township, Argenteuil county, and in Stanstead tp., Stanstead county. A small production was also obtained from Rivière à Pierre in Portneuf county.

In British Columbia granite was quarried on Nelson island about 52 miles north-west of Vancouver, and on Burrard inlet opposite Croker Fold.

The total value of the production in 1906 was $278,419. Statistics of annual production since 1886 are shown in table 7.

TABLE 7.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF GRANITE.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1886	6,062	$63,309	1896	18,717	$106,709
1887	21,217	142,506	1897	10,345	61,934
1888	21,352	147,305	1898	23,897	81,073
1889	10,197	79,624	1899	13,418	90,542
1890	13,307	65,985	1900	....	80,000
1891	13,637	70,056	1901	....	155,000
1892	24,302	89,326	1902	....	210,000
1893	22,521	94,393	1903	....	200,000
1894	16,392	109,936	1904	....	150,000
1895	19,238	84,838	1905	....	226,305
			1906	....	278,419

SLATE.

Slate was quarried at the New Rockland quarries, Richmond county, Que., by Messrs. Fraser & Davies. The Pacific Slate Company of Victoria were making preparations to operate their quarry, but made no shipments during 1906. The total production was valued at $24,416, and about the same quantity has been produced annually during the past four years.

Statistics of the production, exports, and imports of slate are shown in tables 8, 9 and 10.

TABLE 8.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF SLATE.

Calendar Year.	Tons.	Value.
1886	5,345	$64,675
1887	7,357	89,000
1888	5,314	90,689
1889	6.935	119,160
1890	6,368	100,250
1891	5,000	65,000
1892	5.180	69,070
1893	7,112	90,825
1894	....	75,550
1895	....	58,900
1896	....	53,370
1897	....	42,800
1898	....	40,791
1899	....	33,406
1900	....	12,100
1901	715	9,980
1902	....	19,200
1903	....	22,040
1904	....	23,247
1905	....	21,568
1906	....	24,446

TABLE 9.

STRUCTURAL MATERIALS.

EXPORTS OF SLATE.

Calendar Year.	Tons.	Value.
1884	539	$6,845
1885	346	5,274
1886	34	495
1887	27	373
1888	22	475
1889	26	3,303
1890	12	153
1891	15	195
1892	87	2,038
1893	178	3,168
1894	187	3,610
1895	36	574
1896	301	8,913
1897	Nil.	Nil.
1898	Nil.	Nil.
1899	Nil.	Nil.
1900	Nil.	Nil.
1901	16,750	10,000
1902 to 1906	Nil.	Nil.

TABLE 10.

STRUCTURAL MATERIALS.

IMPORTS OF SLATE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$21,431	1893	$51,179
1881	22,184	1894	29,267
1882	24,543	1895	19,471
1883	24,968	1896	24,176
1884	28,816	1897	21,615
1885	28,169	1898	24,907
1886	27,852	1899	33,100
1887	27,845	1900	53,707
1888	23,151	1901	72,187
1889	41,370	1902	72,601
1890	22,871	1903	84,437
1891	46,104	1904	86,057
1892	50,441	1905	93,228

		Duty.	
1906	Slate and manufactures of—		
	Mantels	30 %	
	Roofing slate	25% not over 75c. per square	$60,054
	School writing slates	25 %	20,535
	Slate pencils	25 %	3,329
	Slate of all kinds and manufactures of, N.E.S.	30 %	29,023
	Total	......	$112,941

FLAGSTONES.

A small quantity of flagstone is annually quarried at Bishops Crossing, Que., and sold in Sherbrooke, Iberville, St. Johns, and St. Hyacinthe. The production in 1906 was 6,600 yards, superficial measure, valued at $5,280.

Statistics of production and imports are shown in tables 11 and 12.

TABLE 11.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF FLAGSTONE.

Calendar Year.	Quantity, Sq. ft.	Value.
1886	70,000	$ 7,875
1887	116,000	11,600
1888	64,800	6,580
1889	14,000	1,400
1890	17,865	1,643
1891	27,300	2,721
1892	13,700	1,869
1893	40,500	3,487
1894	152,700	5,298
1895	80,005	6,687
1896	....	6,710
1897	....	7,190
1898	....	4,250
1899	....	7,600
1900	....	5,250
1901	....	4,575
1902	87,300	7,760
1903	79,200	6,688
1904	75,600	6,720
1905	81,000	7,650
1906	59,400	5,280

TABLE 12.

STRUCTURAL MATERIALS.

IMPORTS OF FLAGSTONE.

Fiscal Year.	Tons.	Value.	Fiscal Year.	Tons.	Value.
1881	23	$ 241	1893	884	$ 8,500
1882	90	848	1894	218	2,429
1883	10	99	1895	15	84
1884	137	1,158	1896	Nil.	Nil.
1885	205	1,756	1897	13	227
1886	1,602	9,443	1898	587	1,540
1887	1,316	10,966	1899	Nil.	Nil.
1888	2,642	21,077	1900	9	63
1889	1,669	15,451	1901	14	116
1890	5,665	48,995	1902	232	1,231
1891	3,770	36,348	1903 to 1906*	Nil.	Nil.
1892	1,571	15,048			

* Flagstones dressed. Duty, 20 %. (See table 3).

CEMENT.

The total sales of cement in 1906, including both natural and Portland, amounted to 2,128,374 barrels valued at $3,170,859, as compared with 1,360,732 barrels valued at $1,924,014 in 1905; an increase of 767,642 barrels or 56·4 p. c. in quantity, and $1,246,845 or 64·8 p.

c. in total value. The production of Portland cement continues to show large annual increases, while the output of natural rock cement has fallen off to a few thousand barrels, the proportion of the total in 1906 being less than one-third of one per cent.

Statistics of production since 1887 are given in table 13 below :—

Table 13.

Structural Materials.

Annual Production of Cement.

Calendar Year.	Natural Rock Cement.		Portland Cement.		Total.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
		$		$		$
1887	....	....	....	....	69,843	81,909
1888	....	....	....	....	50,668	35,593
1889	....	....	....	....	90,474	69,790
1890	....	....	....	....	102,216	92,405
1891	....	....	....	....	93,473	108,561
1892	....	....	....	....	117,408	147,663
1893	....	....	....	....	158,597	194,015
1894	....	....	....	....	108,142	144,637
1895	....	....	....	....	128,294	173,675
1896	....	....	....	....	149,090	201,651
1897	85,450	65,893	119,763	209,380	205,213	275,273
1898	87,125	73,412	163,084	324,168	250,209	397,580
1899	147,387	119,308	255,366	513,983	396,753	633,291
1900	125,428	99,994	292,124	562,916	417,552	662,910
1901	133,328	94,415	317,066	565,615	450,394	660,030
1902	127,931	98,932	594,594	1,028,618	722,525	1,127,550
1903	92,252	74,655	627,741	1,150,592	719,993	1,225,247
1904	56,814	50,247	910,358	1,287,992	967,172	1,338,239
1905	14,184	10,274	1,346,548	1,913,740	1,360,732	1,924,014
1906	8,610	6,052	2,119,764	3,164,807	2,128,374	3,170,859

NATURAL ROCK CEMENT.

Natural rock cement was made by two firms only, both in Ontario. The total sales during 1906 were 8,610 barrels valued at $6,052, as compared with 14,184 barrels valued at $10,274 in 1905. The prices realized at the works were 70 to 80 cents per barrel of 240 lbs. net. The extended use of Portland cement, and the preference shown for it by consumers seems, for the time at least, to be driving the natural rock product from the market.

Following is a list of firms owning plants, the first two of which only were operated during the year :—

Hamilton Cement Works .... Hamilton, Ont.
Queenston Cement Works .... Queenston, Ont.
Battle's Thorold Cement Works .... Thorold, Ont.
The Toronto Lime Co. .... Toronto, Ont.
The Manitoba Union Mining Co., Ltd .... Winnipeg, Man.

PORTLAND CEMENT.

The total quantity of Portland cement made in Canada in 1906 was 2,152,562 barrels, as compared with 1,541,568 barrels in 1905, an increase of 610,994 barrels, or 39·6 p. c. The total sales of Portland cement were 2,119,764 barrels, as compared with 1,346,548 barrels in 1905, an increase of 773,216 barrels or 57·4 p. c. Additional details will be found tabulated below.

Fifteen companies were operating plants during 1906, with a total daily capacity of about 10,500 barrels, viz., one in Nova Scotia, two in Quebec, eleven in Ontario, and one in British Columbia. At least four plants were under construction during the year, of which the total initial daily capacity will be about 4,700 barrels.

Detailed statistics of production in 1905 and 1906 are as follows:—

—	1905.	1906.
	Bls.	Bls.
Portland cement sold	1,346,548	2,119,764
Portland cement manufactured	1,541,568	2,152,562
Stock on hand January 1	111,446	*269,558
Stock on hand December 31	*306,466	302,356
Value of cement sold	$1,913,740	$3,164,807

*NOTE.—Some companies do not take stock at the end of the calendar year, consequently their estimates of stock on hand do not always agree from year to year.

The average price per barrel at the works in 1906 was $1.49, as compared with $1.42 in 1905.

The imports of Portland cement into Canada in 1906 were:—

—	Quantity.	Value.
Six months ending June ... cwt.	945,187	$319,021
Six months ending December ... "	1,485,573	459,685
The year 1906 ... "	2,430,760	$778,706

This is equivalent to 694,503 barrels of 350 pounds each, at an average price per barrel of $1.12. The duty is 12½c. per hundred pounds.

The imports in 1905 were equivalent to 917,558 barrels, valued at $1,138,548, or an average price per barrel of $1.24.

There is very little cement exported from Canada. The consumption is therefo:e practically represented by the Canadian sales, together with the imports.

Following is an estimate of the consumption of Portland cement in Canada for the past six years :—

Calendar Year.	Canadian.	Imported.	Total.
	Bls.	Bls.	Bls.
1901	317,066	555,900	872,966
1902	594,594	544,954	1,139,548
1903	627,741	773,678	1,401,419
1904	910,358	784,630	1,694,988
905	1,346,548	917,558	2,264,106
1906	2,119,764	694,503	2,814,267

The exports and imports of cement are shown in tables 14 to 18 following. The exports of cement, as before remarked, are very small, the value in 1906 being $7,551 only. The imports of cement are divided into three groups, of which the most important, Portland cement, amounted in 1906 to the equivalent of 694,503 barrels of 350 pounds net, valued at $963,839. The other imports were hydraulic cement 10,794 cwt. valued at $4,034, and cement not otherwise specified and manufactures of cement to the value of $27,858. The imports of Portland cement showed a steady growth between 1895 and 1905; but began to decrease again in 1906. In 1903 and previous years there was more imported cement used than Canadian product. In 1904 and succeeding years the situation was changed, however, and more Canadian cement was used in Canada than imported, the proportion of imported Portland cement used in 1906 being about 24·6 p. c. of the total consumption.

TABLE 14.
STRUCTURAL MATERIALS.
EXPORTS OF CEMENT.

Calendar Year.	Value.
1891	$ 2,881
1892	938
1893	1,172
1894	482
1895	937
1896	1,328
1897	644
1898	2,117
1899	2,733
1900	3,296
1901	1,514
1902	2,267
1903	2,851
1904	5,494
1905	3,143
1906	7,551

TABLE 15.
STRUCTURAL MATERIALS.
IMPORTS OF CEMENT IN BULK OR BAGS.

Fiscal Year.	Bushels.	Value.	Fiscal Year.	Bushels.	Value.
1880	65	$ 28	1893	12,534	$ 2,909
1881	579	298	1894	9,027	2,618
1882	386	86	1895		2,112
1883	1,759	548	1896		3,672
1884	4,626	1,236	1897		4,318
1885	4,598	1,315	1898		3,263
1886	6,808	1,851	1899		8,929
1887	5,421	1,419	1900		10,452
1888	23,919	5,787	1901		4,890
1889	32,818	10,668	1902		12,234
1890	21,055	5,443	1903		16,281
1891	11,281	2,890	1904		14,305
1892	14,351	3,394	1905*		18,489
			1906*		27,858

* Cement, N.E.S., and manufactures of cement, Duty 20 per cent.

TABLE 16.

STRUCTURAL MATERIALS.

IMPORTS OF HYDRAULIC CEMENT.

Fiscal Year.	Barrels.	Value.
1880	10,034	$ 10,306
1881	7,812	7,821
1882	11,945	13,410
1883	11,659	13,755
1884	8,606	9,514
1885	5,613	5,396
1886	6,164	6,028
1887	6,160	8,784
1888	5,636	7,522
1889	5,835	7,467
1890	5,440	9,048
1891	3,515	6,152
1892	2,214	2,782
1893	4,896	8,060
1894	1,054	985
1895	5,333	7,001
1896	5,688	8,948
1897	2,494	3,937
	Cwt.	
1898	16,033	7,097
1899	1,678	694
1900	10,418	4,711
1901	17,784	6,865
1902	29,585	17,755
1903	13,690	6,333
1904	12,088	5,391
1905	16,961	10,690
1906*	10,794	4,034

* Duty, 12½c. per 100 lbs.

TABLE 17.

STRUCTURAL MATERIALS.

IMPORTS OF PORTLAND CEMENT.

Fiscal Year.	Barrels.	Value.	Fiscal Year.	Barrels.	Value.
1880		$ 55,774	1894	224,150	$280,841
1881		45,646	1895	196,281	242,813
1882		66,579	1896	204,407	242,409
1883		102,537	1897	210,871	252,587
1884		102,857		Cwt.	
1885		111,521	1898	1,073,058	355,264
1886		120,398	1899	1,300,424	467,994
1887	102,750	148,054	1900	1,301,361	498,607
1888	122,402	177,158	1901	1,612,432	654,595
1889	122,273	179,406	1902	1,971,616	833,657
1890	192,322	313,572	1903	2,316,853	868,131
1891	183,728	304,648	1904	2,476,388	995,017
1892	187,233	281,553	1905	3,228,394	1,234,649
1893	229,492	316,179	1906*	2,848,582	963,839

* Duty, 12½c. per 100 lbs.

TABLE 18.

STRUCTURAL MATERIALS.

PRODUCTION OF ROOFING CEMENT.

Fiscal Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895	....	3,153
1896	86	430
1897 to 1906 inclusive	Nil.	Nil.

Following is a list of companies engaged in the manufacture of Portland cement during 1906 :—

Sydney Cement Co	Sydney, C.B.
Crescent Cement Works	Longue Point, Que.
International Portland Cement Co	Toronto, Ont., and Hull, Que.
Canadian Portland Cement Co	Deseronto, Ont.
Lakefield Portland Cement Co	Lakefield, Ont.
Imperial Portland Cement Co	Owen Sound, Ont.
Owen Sound Portland Cement Co., Ltd	"
Grey and Bruce Portland Cement Co., Ltd	"
Sun Portland Cement Co	"
Hanover Portland Cement Co	Hanover, Ont.
Belleville Portland Cement Co	Belleville, Ont.
Ontario Portland Cement Co	Brantford, Ont.
Raven Lake Portland Cement Co	Toronto and Victoria Road, Ont.
National Portland Cement Co	Toronto and Durham, Ont.
Vancouver Portland Cement Co	Victoria, B.C.

Companies with works in process of erection, and companies proposing to erect plants : —

Colonial Portland Cement Co	Wiarton, Ont.
Superior Portland Cement Co	Orangeville, Ont.
Standard Portland Cement Co	Toronto, Ont.
Lehigh Portland Cement Co	Belleville, Ont.
Manitoba Portland Cement Co	Winnipeg, Man.
Alberta Portland Cement Co	Calgary, Alta.
Western Canada Coal and Cement Co	Exshaw, Alta.

LIME.

Statistics of the production of lime in 1906 are more complete than have been available in past years. According to returns received, the total sales and shipments were 3,230,406 bushels valued at $1,009,177. This simply represents the aggregate of the returns received, no allowance or estimate being made for the production of kilns not reported, of which there were undoubtedly a number.

By provinces the production was as follows :—

—	Bushels.	Value.
Nova Scotia	50,000	$13,600
New Brunswick	405,450	94,290
Quebec	923,563	201,816
Ontario	2,885,000	496,785
Manitoba	620,201	119,792
Alberta	240,000	56,200
British Columbia	106,192	26,694
	5,230,406	$1,009,177

The production of lime in Ontario as given above is as published by the Ontario Bureau of Mines. The production in all the other provinces are from direct returns collected by this Department.

Statistics of the production, exports, and imports of lime are shown in tables 19, 20, 21.

TABLE 19.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF LIME.

Calendar Year.	Value.	Calendar Year.	Value.
1886	$283,755	1896 estimated	$ 650,000
1887	394,859	1897 "	650,000
1888	339,951	1898 "	650,000
1889	362,848	1899 "	800,000
1890	412,308	1900 "	800,000
1891	251,215	1901 "	830,000
1892	411,270	1902 "	892,000
1893 estimated	900,000	1903 "	900,000
1894 "	900,000	1904 "	780,000
1895 "	700,000	1905 "	750,000
		1906 "	1,009,177

TABLE 20.

STRUCTURAL MATERIALS.

EXPORTS OF LIME.

Calendar Year.	Value.
1891	$119,853
1892	121,535
1893	86,623
1894	83,670
1895	71,697
1896	70,820
1897	53,177
1898	49,594
1899	73,565
1900	80,852
1901	99,194
1902	116,009
1903	131,412
1904	73,838
1905	85,723
1906	57,072

TABLE 21.

STRUCTURAL MATERIALS.

IMPORTS OF LIME.

Fiscal Year.	Barrels.	Value.
1880	6,100	$ 6,013
1881	5,796	4,177
1882	5,064	5,365
1883	7,623	9,224
1884	10,804	11,200
1885	12,072	11,503
1886	11,021	9,347
1887	10,835	8,524
1888	10,142	7,537
1889	13,079	9,363
1890	8,149	5,360
1891	6,259	4,273
1892	6,132	4,241
1893	6,879	4,917
1894	6,766	4,907
1895	12,008	5,743
1896	10,239	7,331
1897	16,108	10,529
1898	12,850	9,002
1899	15,720	11,124
1900	12,865	11,211
1901	19,657	14,534
1902	24,602	17,584
1903	31,108	22,470
1904	54,359	39,639
1905	98,676	71,588
1906 .... Duty, 20 p. c.	134,334	93,630

CLAY PRODUCTS.

Chief amongst the clay industries is the manufacture of brick. Owing to the large number of manufacturers, and the indifference of many in the answering of circular inquiries, the statistics of production are more or less incomplete.

Returns received show total sales of clay brick of all grades during 1906 to be 523,390 thousand valued at $4,102,590 ; as compared with 523,820 thousand valued at $3,933,925 in 1905.

By provinces the sales in 1906 were :—

—	Number.	Value.	Average price per M.
Nova Scotia	16,591,500	$99,536	$5.999
New Brunswick	3,725,000	29,045	7.797
Quebec	66,193,636	535,531	8.090
Ontario	342,860,000	2,539,795	7.407
Manitoba	54,580,955	517,065	9.473
Saskatchewan	12,786,000	136,022	10.638
Alberta	18,036,951	180,217	9.991
British Columbia	8,616,110	65,379	7.587
	523,390,152	4,102,590	$7.838

The production in Ontario as given above is as published by the Ontario Bureau of Mines. The production given for the other provinces represents the direct returns to this Department.

TABLE 22.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF BUILDING BRICKS.

Calendar Year.	M.	Value.
1886		$ 873,600
1887		986,689
1888		1,036,746
1889		1,273,884
1890		1,266,982
1891		1,061,536
1892		1,251,934
1893		1,800,000
1894		1,800,000
1895		1,670,000
1896		1,600,000
1897		1,600,000
1898		1,900,000
1899		2,195,000
1900		2,275,000
1901		2,400,000
1902		2,593,000
1903		2,832,000
1904		2,983,000
1905	523,820	3,933,925
1906	523,390	4,102,590

TABLE 23.

STRUCTURAL MATERIALS.

EXPORTS OF BRICKS.

Calendar Year.	M.	Value.
1891	246	$ 1,163
1892	1,963	12,192
1893	6,073	44,110
1894	1,095	7,405
1895	1,655	8,665
1896	983	5,678
1897	573	2,679
1898	65	442
1899	172	1,351
1900	546	4,528
1901	646	5,189
1902	2,110	12,786
1903	891	5,699
1904	696	5,357
1905	754	5,888
1906	697	6,541

TABLE 24.

STRUCTURAL MATERIALS.

IMPORTS OF BUILDING BRICKS.

Fiscal Year.	Value.
1880	$ 2,067
1881	4,281
1882	24,572
1883	14,234
1884	20,258
1885	14,632
1886	5,929
1887	2,440
1888	20,720
1889	24,585
1890	12,500
1891	9,744
1892	5,075
1893	14,108
1894	18,320
1895	4,705
1896	23,189
1897	10,336
1898	6,652
1899	21,306
1900	19,305
1901	20,677
1902	33,802
1903	28,493
1904	117,468
1905	168,122
1906 ....Duty, 20 p. c.	194,897

TABLE 25.
STRUCTURAL MATERIALS.
IMPORTS OF PAVING BRICK.*

Fiscal Year.	Value.
1898	$ 2,337
1899	23,648
1900	35,644
1901	10,414
1902	16,788
1903	18,811
1904	29,753
1905	32,578
1906	46,008

*Duty 20 p. c.

TABLE 26.
STRUCTURAL MATERIALS.
PRODUCTION OF TERRA COTTA, ETC.

Calendar Year.	Value.	Calendar Year.	Value.
1888	$ 49,800	1897	155,595
1889	Not available.	1898	167,902
1890	90,000	1899	220,258
1891	113,103	1900	259,450
1892	97,239	1901	278,671
1893	55,704	1902	276,241
1894	65,600	1903	405,796
1895	195,123	1904-1906	(a)
1896	83,855		

(a) Included in table 22.

TABLE 27.
STRUCTURAL MATERIALS.
PRODUCTION OF SEWER PIPES, ETC.

Calendar Year.	Value.
1888	$266,320
1889	Not available.
1890	348,000
1891	227,300
1892	367,660
1893	350,000
1894	250,325
1895	257,045
1896	153,875
1897	164,250
1898	181,717
1899	161,546
1900	231,525
1901	248,115
1902	301,965
1903	317,970
1904	440,894
1905	382,000
1906	530,045

TABLE 28.

STRUCTURAL MATERIALS.

IMPORTS OF DRAIN TILES AND SEWER PIPES.

Fiscal Year.		Value.
1880		$ 33,796
1881		37,368
1882		70,065
1883		70,699
1884		71,755
1885		69,589
1886		57,953
1887		71,203
1888		101,257
1889		83,215
1890		77,434
1891		87,195
1892		59,537
1893		39,001
1894		24,625
1895		21,053
1896		19,296
1897		34,286
1898		29,611
1899		33,898
1900		39,149
1901		56,083
1902		55,530
1903		57,352
1904		55,595
1905		102,395
	Duty.	
1906 { Drain tile, not glazed	20 %	$ 4,727
1906 { Drain pipes, sewer pipes, chimney linings or vents, chimney tops and inverted blocks, glazed or unglazed	35 %	131,353
Total	....	$136,080

TABLE 29.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF POTTERY.

Calendar Year.	Value.	Calendar Year.	Value.
1888	$ 27,750	1897	$129,629
1889	Not available.	1898	214,675
1890	195,242	1899	185,000
1891	258,844	1900	200,000
1892	265,811	1901	200,000
1893	213,186	1902	200,000
1894	162,144	1903	200,000
1895	151,588	1904	140,000
1896	163,427	1905	120,000
		1906	150,000

TABLE 30.

STRUCTURAL MATERIALS.

IMPORTS OF EARTHENWARE.

Fiscal Year.	Value.	Fiscal Year.	Value.
1880	$322,333	1893	$709,737
1881	439,029	1894	695,514
1882	646,734	1895	547,935
1883	657,886	1896	575,493
1884	544,586	1897	595,822
1885	511,853	1898	675,874
1886	599,269	1899	916,727
1887	750,691	1900	959,526
1888	697,082	1901	1,114,677
1889	697,949	1902	1,275,093
1890	695,206	1903	1,406,610
1891	634,907	1904	1,611,356
1892	748,810	1905	1,636,214

		Duty.	
1906	Earthenware and china :—		
	Baths, tubs and washstands, of earthenware, stone cement or clay, or of other material, N.O.P.	30 %	$ 67,828
	Brown or coloured earthen and stoneware, and Rockingham ware	30 %	8,363
	Decorated, printed or sponged, and all earthenware, N.E.S.	30 %	191,552
	Demijohns, churns and crocks	30 %	10,508
	White granite or ironstone ware, C.C. or cream coloured ware	30 %	47,960
	Tableware of china porcelain or other clay	30 %	956,064
	China and porcelain ware	30 %	214,013
	Earthenware tiles	35 %	78,247
	Manufactures of earthenware, N.E.S.	30 %	117,824
	Total		1,692,359

TABLE 31.

STRUCTURAL MATERIALS.

EXPORTS OF SAND AND GRAVEL.

Calendar Year.	Tons.	Value.
		$
1893	329,116	121,795
1894	324,656	86,940
1895	277,162	118,359
1896	224,769	80,110
1897	152,963	76,729
1898	165,954	90,498
1899	242,450	101,640
1900	197,558	101,666
1901	197,302	117,465
1902	159,793	119,120
1903	355,792	124,006
1904	399,809	129,803
1905	306,935	152,805
1906	336,550	139,712

INDEX