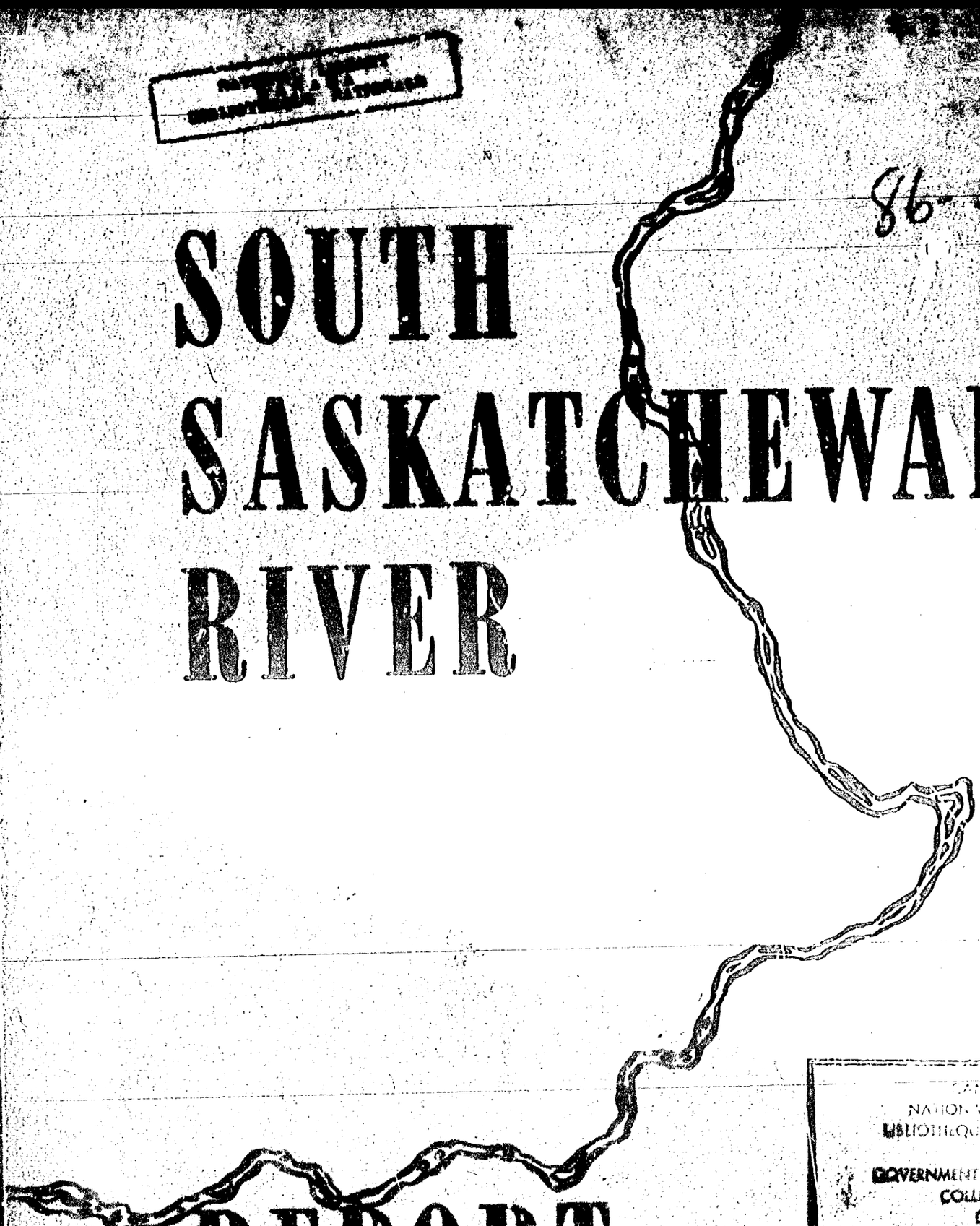
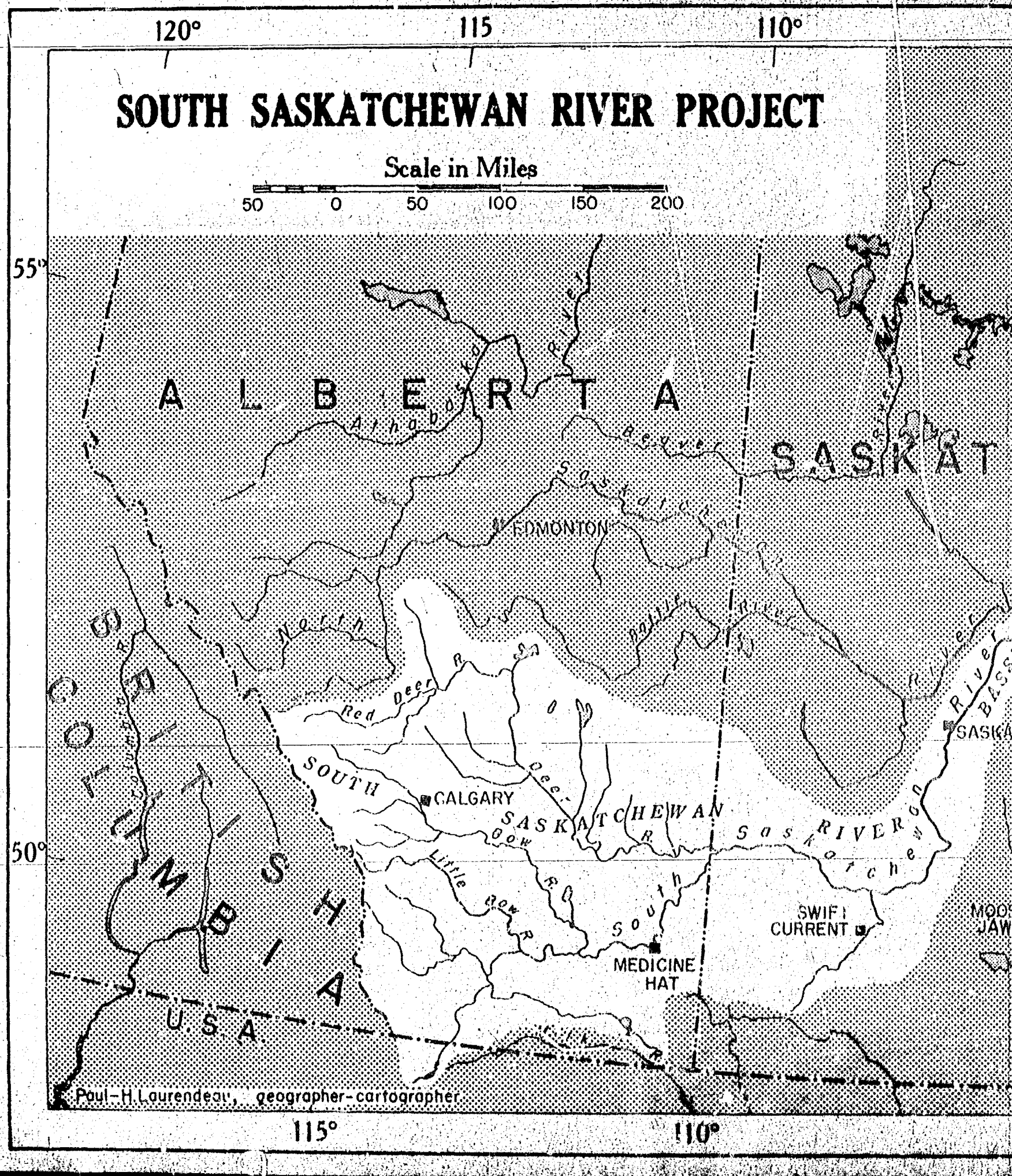
SOUTH SASKATCHEWAN RIVER

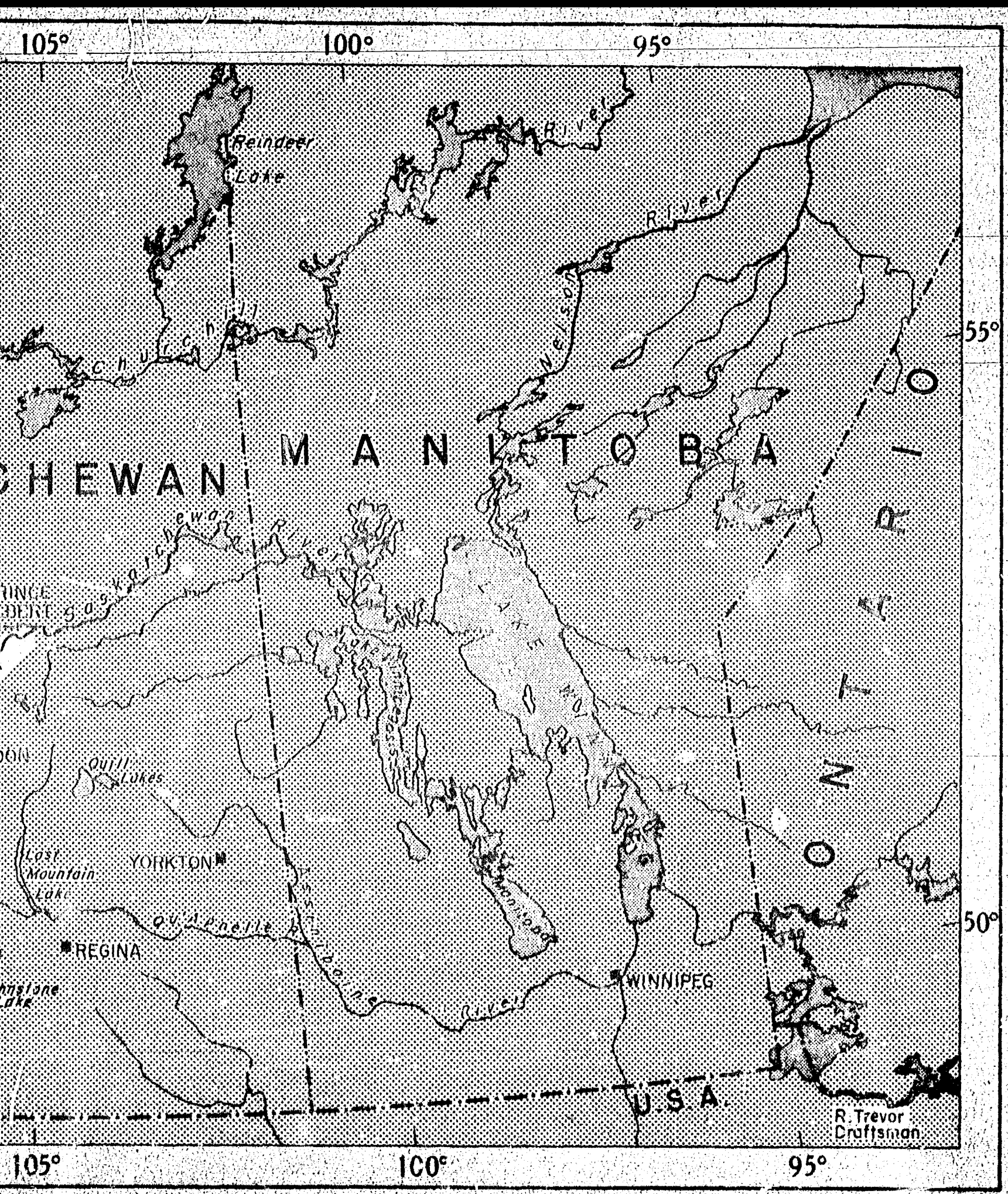


REPORT

OF THE ROYAL COMMISSION ON THE SOUTH SASKATCHEWAN RIVER PROJECT

SOUTH SASKATCHEWAN RIVER PROJECT




105°
100°
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Reindeer Lake
River
Nelson
Churchill
MANITOBA
CHEWAN
Qu'Appelle
Quill Lakes
Last Mountain Lake
YORKTON
REGINA
WINNIPEG
Assiniboine
Red
U.S.A.
R. Trevor
Draftsman

Report of the

Royal Commission on the
South Saskatchewan River Project

REPORT

of the

Royal Commission

on the

South Saskatchewan River

Project

1952

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1952

Royal Commission

on the

South Saskatchewan River Project

1952

COMMISSIONERS

DR. T. H. HOGG, *Chairman*

G. A. GAHERTY, ESQ.

DR. JOHN A. WIDTSOE

B. T. RICHARDSON, ESQ.,
Secretary

GORDON HAASE, ESQ.,
MISS M. ANN MOSLEY
Assistant Secretaries

D. W. HAYS, ESQ.,
Engineering Consultant

J. J. CONNOLLY, ESQ., Q.C.
Commission Counsel

H. CARL GOLDENBERG, ESQ., Q.C.
Special Counsel

A dam, 85 feet high, and 600 to 800 yards long (a few miles lower down the length of the dam would be much less) across the deep narrow valley in which the South Branch flows, below where the Qu'Appelle valley joins it, would send its waters down the Qu'Appelle valley, thence down the Assiniboine past Fort Garry, and thus establish a splendid and probably uninterrupted navigation, for steamers of large size, for a distance exceeding six hundred miles.

—The first proposal to construct a dam in the South Saskatchewan River, made by Henry Youle Hind, M.A., in his Report on the Assiniboine and Saskatchewan Expedition, 1859.

Report

To His Excellency the Governor General in Council

MAY IT PLEASE YOUR EXCELLENCY,

We, the Commissioners, appointed as a Royal Commission in accordance with the terms of an Order in Council dated 24th August, 1951, to conduct an inquiry and to report on the South Saskatchewan River Project (Central Saskatchewan Development):

BEG TO SUBMIT TO YOUR EXCELLENCY
THE FOLLOWING REPORT

The Order in Council

P.C. 4435

Privy Council
[Seal]
Canada

Certified to be a True Copy of a Minute of a Meeting of the Committee of the Privy Council, Approved by His Excellency the Governor General on the 24th August, 1951.

The Committee of the Privy Council, on the recommendation of the Right Honourable Louis S. St. Laurent, the Prime Minister, advise:

1. That under and in pursuance of Part One of the Inquiries Act a commission do issue appointing Commissioners to conduct an inquiry into the following matters, namely:

> Whether the economic and social returns to the Canadian people on the investment in the proposed South Saskatchewan River Project (Central Saskatchewan Development) would be commensurate with the cost thereof;
>
> Whether the said Project represents the most profitable and desirable use which can be made of the physical resources involved.

2. That the following persons be appointed Commissioners pursuant to Part One of the Inquiries Act to conduct the said inquiry:

> Dr. T. H. Hogg, Toronto, Ontario,
> Mr. G. A. Gaherty, Calgary, Alberta, and
> Dr. John A. Widtsoe, Salt Lake City, Utah, U.S.A.

3. That the said Dr. T. H. Hogg be Chairman of the Commission;

4. That Mr. Burton T. Richardson, Ottawa, Ontario, be Secretary to the Commissioners;

5. That for the purposes hereinabove stated, the Commissioners shall have all the powers vested in, or which can be conferred on Commissioners under the Inquiries Act, that all or any of the powers which can be conferred under Part Three of the Inquiries Act may be exercised by any two of the Commissioners, and that departments of the Government of Canada shall afford the Commissioners, and all persons acting under their authority, or by their direction, such assistance and co-operation in the matters of the inquiry as the Commissioners may think desirable;

6. That the Commissioners be further authorized to include in their examination and to report upon all matters which the Commissioners may consider pertinent or relevant to the general scope of the inquiry.

(Signed)

A. M. HILL
Asst. Clerk of the Privy Council.

Commission

appointing

DR. T. H. HOGG, G. A. GAHERTY, ESQUIRE,

and DR. JOHN A. WIDTSOE,

Commissioners under Part I of the Inquiries Act
to inquire into and report upon the feasibility
of the South Saskatchewan River project.

DATED, 24th August, 1951

RECORDED, 25th September, 1951

Lib. 467, Fol. 358

(s) H. W. DOYLE
for DEPUTY REGISTRAR GENERAL OF
CANADA

Refer. No. 135612

Commission of Appointment

(s) R. J. CARTWRIGHT
DEPUTY GOVERNOR GENERAL

[SEAL]

CANADA

GEORGE THE SIXTH, by the Grace of God, of Great Britain, Ireland and the British Dominions beyond the Seas, KING, Defender of the Faith.

TO ALL TO WHOM these Presents shall come or whom the same may in anywise concern,

GREETING:

(s) PAUL FONTAINE
(for)
DEPUTY ATTORNEY GENERAL
CANADA

WHEREAS pursuant to the provisions of Part I of the Inquiries Act, Revised Statutes of Canada, 1927, Chapter ninety-nine, His Excellency the Governor General in Council by Order P.C. 4435 of the Twenty-fourth day of August, in the year of Our Lord one thousand nine hundred and fifty-one, a copy of which is hereto annexed, has authorized the appointment of Our Commissioners therein and hereinafter named to investigate and report:

(1) Whether the economic and social returns to the Canadian people on the investment in the proposed South Saskatchewan River Project (Central Saskatchewan Development) would be commensurate with the cost thereof;

(2) Whether the said Project represents the most profitable and desirable use which can be made of the physical resources involved.

and has conferred certain rights, powers and privileges upon Our said Commissioners as will by reference to the said Order more fully appear.

NOW KNOW YE that by and with the advice of Our Privy Council for Canada, We do by these Presents nominate, constitute and appoint DR. T. H. HOGG, of the City of Toronto, in the Province of Ontario, G. A. GAHERTY, ESQUIRE, of the City of Calgary, in the Province of Alberta, and DR. JOHN A. WIDTSOE, of Salt Lake City, in the State of Utah, United States of America, to be our Commissioners to conduct such inquiry.

TO HAVE, HOLD, EXERCISE and ENJOY the said office, place and trust unto the said T. H. HOGG, G. A. GAHERTY and JOHN A. WIDTSOE together with the rights, powers, privileges and emoluments unto the said office, place and trust, of right and by law appertaining, during pleasure.

AND WE do hereby further appoint the said T. H. HOGG to be Chairman of Our said Commissioners.

IN TESTIMONY WHEREOF We have caused these Our Letters to be made Patent and the Great Seal of Canada to be hereunto affixed.

WITNESS: Our Right Trusty and Well-beloved Counsellor the Honourable John Robert Cartwright, Puisne Judge of the Supreme Court of Canada and Deputy of Our Right Trusty and Well-beloved Cousin, Harold Rupert Leofric George Viscount Alexander of Tunis, Knight of Our Most Noble Order of the Garter, Knight Grand Cross of Our Most Honourable Order of the Bath, Knight Grand Cross of Our Most Distinguished Order of Saint Michael and Saint George, Companion of Our Most Exalted Order of the Star of India, Companion of Our Distinguished Service Order, upon whom has been conferred the Decoration of the Military Cross, Field Marshal in Our Army, Governor General and Commander-in-Chief of Canada.

AT OUR GOVERNMENT HOUSE, in Our City of Ottawa, this Twenty-fourth day of August in the year of Our Lord One thousand nine hundred and fifty-one and in the Fifteenth year of Our Reign.

BY COMMAND

(s) C. STEIN
UNDER SECRETARY OF STATE

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PART I

Recommendations and General Considerations

Recommendations and General Considerations

1. The Commission was established to inquire whether the economic and social benefits of the South Saskatchewan River Project would be commensurate with the cost and whether the Project represents the most profitable and desirable use which can be made of the physical resources involved. The Commissioners were also authorized to inquire into and report upon all other matters which they deemed pertinent to their inquiry. The purpose of the South Saskatchewan River Project is to irrigate an estimated 455,000 acres of land in Central Saskatchewan by constructing a dam 205 feet in height across the South Saskatchewan River near Outlook, the site being just above the mouth of Coteau Creek. Associated with the plans for irrigation, it is proposed to develop 150,000 horsepower at the dam, part of which would be used to pump water to heights of from 15 to 120 feet to irrigate approximately 307,000 acres of the total area. It includes provision for supplying water for domestic use, greatly needed in the cities of Moose Jaw and Regina.

2. The Canadian Prairie Provinces, in which 123,000,000 acres are in occupied farms, include an area, roughly triangular in shape, in which the problems arising from low rainfall are exceptionally acute. This area extends along the international border south of Estevan, Saskatchewan, to the vicinity of Lethbridge, Alberta, and has its apex to the west of Saskatoon, roughly in the neighborhood of Macklin, Saskatchewan. It was first explored in 1857-60 by Captain John Palliser of the Royal Engineers and declared to be arid and unpromising for human habitation. It is commonly known as Palliser's Triangle. It includes some lands that are farmed successfully by modern dry farming methods and some areas of consistent crop failure. In seasons of drought, the failure of crops often extends beyond its confines. In the heart of Palliser's Triangle is an inner triangle, possibly amounting to 15,000,000 acres lying both in Saskatchewan and in Alberta. Some lands therein once were tilled, and are now abandoned. In the inner triangle, the problem is one of reclamation of land which, without irrigation to supplement rainfall, will likely remain of little value for agriculture. Elsewhere the benefit of irrigation is to increase and stabilize the yield of lands already being farmed with more or less success.

3. Where the annual precipitation is deficient great benefit often accrues if supplementary water is provided. All the water of the South Saskatchewan River and all that could be diverted from the North Saskatchewan, however, would irrigate only

3,000,000 acres, more or less. At present there are 610,000 acres under irrigation and 450,000 more will be irrigated when works now planned and under construction are completed. It is evident that only a small proportion of the lands that could be made more productive with supplementary water can be irrigated. The limit of water supply from streams in the Saskatchewan River Basin may be reached in the foreseeable future. Water is one of the most important resources of the region available for enlarging and stabilizing its agriculture.

4. The topography of Palliser's Triangle makes irrigation costly. The main rivers traverse the region in wide valleys from three to five hundred feet below the general ground level. To command the uplands, the water must be diverted far upstream and conveyed in long canals to points of use. Otherwise, high dams must be constructed in deep valleys, where foundation conditions generally are uncertain, or the water must be pumped to heights that are likely to be beyond the economic limits of cost. To discover the best alternative, comprehensive Basin-wide investigation and planning are indispensable.

5. Much investigation and development have been carried out by official agencies such as the former Reclamation Service and the administration of the Prairie Farm Rehabilitation Act, as well as by irrigation districts and former private companies. Further agronomic and engineering studies are a prerequisite to determine where irrigation will be the most productive and where the cost of irrigating is economic. While the best use of water is an urgent consideration in the Saskatchewan River Basin, the problem has not been understood in its broadest aspects, nor have solutions to it been conceived in terms of the fullest ultimate use of available water. The scope of the problem is vast so that the selection of projects for water utilization must take into account the general public interest as well as sectional claims.

6. Apart from the cost of bringing water to the farm, irrigation involves extra cost and work on the part of the farmer in distributing the water over his land. Wheat is not generally a profitable crop on irrigated land. Provided the water is furnished at reasonable cost, irrigation can be carried out on a grain-hay-livestock basis and this fits in well with pasturage on adjacent dry lands. The irrigation of specialty crops such as sugar beets and canning vegetables will stand much higher water charges. But the market for such crops in the area in question is at present too small to be much of a factor. Irrigation produces a stable agricultural economy within the limits of a project but the benefits to agriculture cannot be expected to extend much beyond the irrigated area.

7. Irrigation is a consumptive use of water, though it is only one use to which the flow of a river may be put. The development of large irrigation projects where they are desirable will foreclose other uses, such as hydro-electric power schemes lower down on the same river. Equally, the development of power plants on the lower reaches of the Saskatchewan River would create perpetual claims upon the flow which could not be disregarded when the need arises for

an expansion of irrigated acreage in the arid region through which the South Branch of the river passes.

8. For irrigation there is no substitute for water whereas for generating power there are alternatives. The proposal to commit for hydro-electric power approximately four-fifths of the flow of the South Saskatchewan River at the Coteau Creek damsite, where it could never be returned for irrigation in the arid territory above the site, would scarcely survive as part of a program of integrated development of the Basin directed to the ultimate objective of utilizing the full flow for irrigating the dry lands of Western Canada. Moreover, the large scale abstractive use of water for irrigation in eastern Alberta and western Saskatchewan would be at the expense of a serious loss of hydro-electric power at undeveloped sites on the lower Saskatchewan and Nelson Rivers.

9. The economy of the Prairies and particularly of Saskatchewan has obvious weaknesses. Although the average production per farmer over the years compares favourably with that of the rest of Canada, the vagaries of climate result at times in crop failures which in extreme cases extend beyond the confines of Palliser's Triangle. This creates relief problems and, as Saskatchewan's brief put it in a striking phrase, "the immeasurable destitution of the land and its people." The wheat crop of Saskatchewan, which is the Province's principal source of wealth, has fluctuated from 36,000,000 to more than 400,000,000 bushels. In addition, the mechanization of the wheat farm has contributed to the depopulation of the countryside. "As a result of these conditions", the brief said, "private business and public services, both municipal and provincial, are under a constant threat of disruption."

10. Argument advanced on behalf of the Project at the hearings of the Commission in Saskatchewan stressed the disastrous economic and social consequences of these conditions upon the life of the people of Saskatchewan. The Saskatchewan submission said: "There is a great need, firstly, for assured feed supplies to permit diversification of the economy through livestock production and, secondly, for new land on which to settle insecure farmers. Neither of these needs can be adequately filled without the Central Saskatchewan Development." The problem is so complex and so far-reaching in its implications that the Commission feels constrained to point out that the remedies would lead far beyond its terms of reference. A word of caution is required against excessive expectation that this problem can be solved by one bold stroke. The economy of Saskatchewan is vulnerable through being restricted in large degree to one-crop agriculture. This condition may be ameliorated by industrial development in the Province, by diversified land use as a result of changing demands for farm products, and by the exploitation of the resources of forest and mineral regions in the north.

11. The lands it is proposed to irrigate by the South Saskatchewan River Project lie on the northeastern fringe of Palliser's Triangle. There those farmers who are successfully farming large acreages by dry farming methods are unlikely in many cases to take kindly to having their farms broken

up into small blocks suitable for irrigation. This has been the experience in irrigation projects elsewhere. There are cases where dry land farmers have successfully resisted plans to incorporate their holdings into irrigation developments. How the large holdings in the Project would be made available in small blocks for irrigation was not discussed at the Commission's hearings. Nevertheless, the territory included in and affected by the Project would be helped greatly by irrigation. If it came into successful operation, it would have favourable effects on the economy of the Province. It would provide opportunities and amenities to attract new population.

12. From studies of the Project the soils are suitable and the amount of water available is adequate for irrigation development. However, the land is situated in a climatic zone that imposes limitations on the crops that can be grown. Futhermore, a readily available market for specialty crops is not apparent at this time.

13. The Project is so situated as to require water to be pumped to heights of 15 to 120 feet to irrigate about two-thirds of the gross irrigable area. This would materially increase operational costs. It is doubtful whether the farmers in all areas would be amenable to such high costs for irrigation, in view of the competing attraction of dry farming opportunities which exist within the Project.

14. The risk of a failure of sustained irrigation for all parts of the Project, such as has occurred in certain irrigation projects in Alberta where over 150,000 acres of irrigated land have reverted to dry farming, warns that the cause of irrigation would receive a set-back from which it would take years to recover, if the Project were undertaken in the light of mistaken judgment.

15. Estimates of the period required to construct the Project range upwards from a minimum of six and a half years. The development of the irrigation areas to a point approximating maturity would require from 35 to 50 years. Maximum returns, therefore, would be deferred for a long period of time.

16. Reports of the Prairie Farm Rehabilitation Administration and its advisers, eminent engineers in this field, assert that the Coteau Creek Dam can be constructed successfully. This question is not specifically included in the terms of reference. In view of the unfavourable foundation and other conditions at the site and the costly construction difficulties that might therefore be expected in building a high dam there, the Commission did concern itself with the cost of a structure that would be safe. Even where construction is less harzardous, the cost is apt to be underestimated, as in the St. Mary-Milk River Project where the anticipated final cost of $45,000,000 compares with an original estimate of $15,000,000.

17. The Commission is of the opinion that the South Saskatchewan River Project would cost at least $250,000,000, of which the Coteau Creek reservoir and power station would represent $175,000,000. Deducting $30,000,000 for the value of the power development and allowing $20,000,000 for the value of social and other benefits, including the domestic water supply of the cities of Regina and Moose Jaw, the remaining cost chargeable to irrigation would be over $70,000 for each farm unit. On the basis

of the agreement on the division of costs of large irrigation projects set out in P.C. 2298, June 19, 1947, the share of the Province of Saskatchewan for the power plant, the irrigation system including pumping installations, and the cost of land acquisition in the irrigable area would be some $100,000,000.

18. That costs of this order are to be expected is indicated by a recent estimate of $290,000,000 for the Garrison reservoir and power station now being built on the Missouri River by the U.S. Corps of Engineers. Although the structure is somewhat larger, geological and topographical conditions are generally similar. This estimate includes no provision for irrigation.

19. The economic value of water power is determined by the cost of producing power from alternative available sources. The cost of providing power facilities at the Coteau Creek Dam is such that Saskatchewan's power needs can be provided almost as cheaply from steam plants situated near the main load centres or near low cost sources of fuel. The development of power at the proposed Coteau Creek Dam can, therefore, have little significance in the consideration of the South Saskatchewan River Project.

20. Construction of the Project under conditions approaching full employment would force the curtailment of other productive efforts. There is no justification for denying to the Canadian consumer the benefit of productive activities that would be curtailed if the Project were undertaken under present conditions. A need for new employment opportunities and conditions in which new public investment would not create inflationary pressure upon the price level, would favour the Project, always assuming that it would not foreclose more profitable and desirable plans of Basin development.

21. Three main considerations have influenced the Commission:

A. *The cost of the South Saskatchewan River Project would be large.* The total cost of the Project would tend to place too great a burden upon the land or upon the farmer. The cost to the farmers of converting existing dry land into irrigated farms must be kept within reasonably well understood limits. Equally, the cost to the taxpayer must be kept within limits. The cost of the Project is so high that the Commission is confident that irrigation farms can still be created, as they have in the past, at less cost elsewhere in the Saskatchewan River Basin. While the cost of the Project needs to be considered in part a subsidy, it should not be regarded as a private investment in which the main concern would necessarily be the recovery of capital with interest in the usual fashion. Indirect returns from public investment are substantial, even though they cannot be accounted for strictly in dollars and cents. Public investment undertaken with proper safeguards and foresight, is necessary in order to achieve the broad aims of nation building. There are large and satisfactory returns to be secured, which add to the economic expansion of the country and contribute to social

progress. It remains a question in the Commission's mind to what extent such subsidy as may be required for the South Saskatchewan River Project, may be justified by anticipated demands for agricultural land and increased food production.

B. *Other projects seem likely to afford a more profitable and desirable use of the physical resources involved.* While some agronomic aspects of the Project favour a decision to launch irrigation enterprises in the Project area, particularly in the southern portions of it, the evidence suggests that greater benefits may be obtained elsewhere from comparable investment in irrigation. Comparable investment in the use of the water upstream may prove more profitable, especially if it made possible the irrigation of land which is extremely dry and which is not occupied by dry land farmers who would have to be closed out.

C. *A realistic nation-wide approach is needed.* Back of all planning and discussions of such an undertaking as the South Saskatchewan River Project must lie the feeling that all parts of Canada have equal rights in seeking full development. Canadians shall fail if they do not view the development of Saskatchewan as one of the vital parts of the development of Canada. The Commission feels that the development of irrigation in Central Saskatchewan is essentially a task of statesmanship involving the provision of lands and social amenities for generations of contented, useful citizens.

Findings and Recommendations

1. The Commission finds that at present the economic returns to the Canadian people on the investment in the proposed South Saskatchewan River Project (Central Saskatchewan Development) are not commensurate with the cost thereof; though the Project would yield social returns which, while they cannot be measured for the purpose of this Report, would be of great value to the region in which it is situated.

2. The Commission recommends that, when the time comes that the Project represents the then best use of water for irrigation, the present finding should be reviewed in the light of changing conditions. Among others, the following considerations might then be taken into account:

(a) The prospect of adequate markets for the specialty crops, such as sugar beets, canning vegetables, potatoes, etc., that could be grown on the area it is proposed to irrigate;

(b) The Canadian demand for farm products which, when it comes more nearly

into balance with production, would require a more intensive use of land resources;

(c) A significant change in relationship of the price of farm products and construction costs;

(d) The necessity for the construction of public works for the relief of unemployment.

3. The Commission finds that the available data, which are by no means complete, indicate that the said Project does not represent the most profitable and desirable use which can be made of the physical resources involved.

4. The Commission recommends, in respect to No. 3 above, that further study be given to the merits of:

(a) Irrigating the area that needs water most, namely, the arid core of the region known as Palliser's Triangle, which lies in eastern Alberta and western Saskatchewan;

(b) Bringing additional land under irrigation in the Saskatchewan River Basin by pumping water direct from the River and from existing irrigation canals or extensions thereof;

(c) The development known as the Red Deer River Project, including its possible extension into the Province of Saskatchewan.

5. The Commission finds that the future demand for water for irrigation could be such as to exhaust the available flow of the South Saskatchewan River, and recommends, therefore, that without delay a comprehensive, long-range program be developed that would result, over the years, in the most beneficial use being made in the interests of the people of Canada of the waters of the Saskatchewan River from its head waters to the sea.

6. The Commission finds that to implement a Basin program, the conflict between the upstream consumptive use of the water for irrigation and its downstream use for generating power will have to be resolved.

7. The Commission recommends, in respect to No. 5 above that:

(a) The requisite data be gathered by the appropriate governmental services, Federal and Provincial;

(b) Agronomic and engineering studies be made in respect to all potentially irrigable areas within the Saskatchewan River Basin;

(c) The feasibility be determined of augmenting the water supply available for irrigation by means of a diversion of the North Saskatchewan River above Rocky Mountain House into the Clearwater River and, in turn, into the Red Deer River;

(d) Studies be inaugurated to determine the effects of existing and future irrigation projects in Alberta and Saskatchewan upon the development of power downstream on the Saskatchewan and Nelson Rivers;

(e) The possibility be explored of making good in part any reduction in hydro-electric power arising from the upstream consumptive use of water for irrigation, by means of a diversion from the Athabasca River Basin into the North Saskatchewan River and also by a diversion from the Churchill

River by way of the Sturgeon-Weir River into the Saskatchewan Basin;

(f) The Government of Canada make available appropriate administrative and other machinery for collecting and correlating relevant data for making the required studies and for developing and coordinating a Basin program.

8. The Commission recommends, having regard particularly to the needs of the Province of Saskatchewan, that immediate consideration be given to:

(a) The development of the resources of the Qu'Appelle River Valley by providing adequate facilities to pump water from the South Saskatchewan River or by other means, in order to furnish municipal water supplies for the cities of Regina and Moose Jaw and to realize within economic limits all irrigation benefits and social and recreational opportunities therein.

(b) The irrigation of lands in Central Saskatchewan within reach of the South Saskatchewan River by pumping water direct from the River wherever economically feasible.

9. The Commission recommends that early consideration be given to the reclamation by dyking and drainage of some 100,000 acres in the area known as the Pasquia Project, as a first step in the reclamation of fertile delta lands lying at the forks of the Carrot, Pasquia and Saskatchewan Rivers, in order to encourage the orderly, integrated development of an agricultural region that is likely to be of crucial importance in the mineral and industrial development of northern Manitoba and Saskatchewan. Development of delta lands would provide re-settlement opportunities that are greatly needed and which can be met to a limited degree only by irrigation development.

10. The Commission recommends that irrigation projects that are under construction and possible extensions thereto should be pushed to completion, and that early investigations be made of such projects as may be constructed at a reasonable cost so that the development of irrigation may proceed as rapidly as is consistent with economic conditions and agricultural needs.

General Considerations

1. The Commission was established by P.C. 4435 on August 24th, 1951, to inquire into the following:

Whether the economic and social returns to the Canadian people on the investment in the proposed South Saskatchewan River Project (Central Saskatchewan Development) would be commensurate with the cost thereof;

Whether the said Project represents the most profitable and desirable use which can be made of the physical resources involved.

The following paragraph is of importance:

That the Commissioners be further authorized to include in their examination and to report upon all matters which the Commissioners may consider pertinent or relevant to the general scope of the inquiry.

2. In determining whether the economic and social benefits of the South Saskatchewan River Project would be commensurate with the cost thereof, the Commission has had much help from the engineering and other researches begun by the Prairie Farm Rehabilitation Administration in 1943 and carried on continuously since 1947. Few proposals of public investment have had the advantage of preliminary study on the extensive scale given to this Project by the P.F.R.A. Engineering studies of possible sites had guided the selection of a site for a dam on the river below the Alberta boundary and had fixed in general the design of the structure. In addition, the reports available to the Commission dealt in a comprehensive way with climate, soils, power, economic benefits, land and development policy, the development of irrigation in Alberta, and recreational aspects. Without this excellent and exhaustive material, which represented many months of painstaking and, in some instances, original research, the Commission's task would have been impossible.

3. The P.F.R.A. reports were presented to Parliament on September 7, 1950 (Sessional Paper 95A). A summary of these reports was tabled on June 29, 1951. It was necessary, for the Commission's purpose, to examine this information in detail at the outset. At the same time, the Commission was bound by the terms of reference to consider the broad question whether the Project represents the most profitable and desirable use which can be made of the physical resources involved.

4. The first part of the reference compelled the Commission to examine the South Saskatchewan River Project with special reference to the benefits it would confer upon the Canadian people and, as well, its cost. In order to determine whether benefits are "commensurate" with cost, it appeared that an attempt should be made to draw up a balance sheet setting out returns on one side and costs on the other. The obvious limitation of this method was that, while direct economic returns are measurable, the indirect economic benefits and the social values cannot be reduced to dollars and cents. Yet by estimating as closely as possible those benefits that can be measured, and by analyzing the cost in the light of the best available engineering knowledge and experience in construction, the Commission has sought to show the approximate figure at which the indirect economic and social benefits would have to be valued to effect a balance of costs and returns.

5. The question of the engineering feasibility of the Coteau Creek Dam did not enter into the Commission's inquiry, except insofar as the Commissioners undertook to satisfy themselves on the general details of an undertaking that involves some uncommon engineering problems. There are obvious difficulties in the creation of a reservoir on the South Saskatchewan River where the P.F.R.A. has selected its site, and the safety of the structure would be a matter of concern to its builders. The works to be constructed would exceed any comparable engineering project in Canada, and would compare with like projects constructed in a similar environment in the United States. The foundations upon which the large dam would rest are hardly the sort which engineers would choose if an alternative site existed. The Project requires a heavy

structure to be built upon 80 to 100 feet of detritus, consisting of silt, sand, gravel and rock of the river bottom. The problem of de-watering during a long period of construction, in which exceptionally high water levels may recur, presents some grave risks. In terms of cost, a substantial over-run of estimates can be expected, and the cost must be indeterminate until the construction of such a Project would be complete. For these reasons, the Commissioners had to satisfy themselves that the estimate of cost was made on a sound basis.

6. Public investment, moreover, must take into account not only the financial cost of a project, but also its real cost in terms of competing demands upon the resources of Canada and the relative value of realizable benefits. This aspect of the inquiry, like several oth aspects of crucial importance, had not been investigated prior to the Commission's inquiry. In half a century, an aggrega'e expenditure of $85,000,000 has brought more than 600,000 acres of dry land under irrigation from the tributaries of the South Saskatchewan River. Yet the Commission discovered that there had been relatively little prior inquiry into the economic and social values of capital expenditures of this kind. The economic literature dealing with investment in irrigation in Canada remains today remarkably slight. It became obvious to the Commission, that, to discharge properly the duty laid upon it by the terms of reference, its inquiry would have to be extended beyond the limits that first appeared appropriate. To assess the economic and social values of the Project and to determine the accountable returns from an investment in it has involved research into matters of practical importance not often taken into account in irrigation policy in the past.

The Importance of the Prairies to Canada's Economy

7. The commercial attributes of agricultural expansion in Western Canada have been defined with great lucidity by Professor Fowke in his historical review of the economic development of the Prairie Provinces, prepared for the Commission. (Part II, Chapter 3)

> Western agriculture expansion, (he wrote) led to eastern urbanization, to the growth and prosperity of commercial and industrial centres. To equip and service the agricultural frontier there was necessarily a tremendous increase in the manufacturing, merchandising and transportation facilities of the country. The frontier farmer is typically a trader. He sells much and buys more, financing the difference by the accumulation of debt. Westward over the continental trade routes, over rivers and increasingly over railways, there moved the manufactured products of eastern cities. Eastward in return there moved the products of the expanding agricultural areas, cereals, livestock and and livestock products. The national income and the national revenues multiplied, partly as a direct result of increased agricultural production but more particularly because of the commercial and industrial employments which followed inevitably in the wake of agricultural immigration and settlement.

The typical economic interpretation of Canadian development, according to Fowke, has consistently underestimated the commercial importance of agricultural immigration and settlement processes. The Canadian frontiersman has typically been a substantial buyer and seller of goods and has consequently been of direct practical interest to commercial and industrial groups. The points

to be noted, he wrote, "are (1) that the economic purposes of the national policy were essentially commercial, and (2) that western agricultural development came to represent a substantial part of the objectives of the national policy, largely because of the recognized commercial attributes of large-scale immigration and settlement".

8. The commercial frontier has followed the agricultural frontier in the past. The future development of Canada requires that agricultural progress shall be maintained. Farm expansion requires additions to the labour force of the nation and the provision of an entire range of capital equipment. It requires the outfitting of new farm units with buildings, machinery, household furnishings, and a wide variety of incidental equipment. It calls for expansion in transportation facilities and market centres. It invokes a demand for the products of Canadian manufacturing industry. Agriculture has been a key element in Canadian prosperity. The gains from it should be consolidated. It is within this context that the question of the economic value of the South Saskatchewan River Project and the wider issue of the beneficial use of the resources of fertile but arid land and the supply of water available in that river, must be judged.

9. Agriculture in the Prairie Provinces has been of high importance to the economic life of Canada and will continue to be so. During the past decade these provinces have produced each year almost half the products sold off the farms of Canada, though only one in five Canadians lives on the Prairies. Just as the prosperity of Canada is linked intimately with that of the West, the economic troubles of the Prairie region have fateful consequences for the entire nation. The setback suffered by the western wheat economy in the 1930's through drought and depressed prices was a disaster in which all Canada shared. The expenditures for relief works and other relief made by all governments in Canada in 1930-40 amounted to $1,291,000,000, of which nearly half was furnished by the Federal Government. Saskatchewan alone required nearly one-quarter of the entire expenditures in Canada in the 1930's for relief and similar types of assistance. Financial assistance to farmers in the Province, the Saskatchewan government informed the Commission, has amounted to $340,100,000 since 1907, of which $153,600,000 was furnished by the Federal Government. An additional amount of $125,000,000 arose from debt adjustment and tax cancellations. Most of this relief total was provided in 1929-39.

10. The magnitude of the drought disaster of the 1930's, which left so deep an imprint upon the Prairie Provinces, cannot be measured in financial statistics, such as the relief figures or the decline in physical production and in economic values. The average cash income from the sale of farm products in the Prairie Provinces, which was $1,053,400,000 in 1946-50, had been only $204,800,000 in 1930-34. In the 1920's this income had been four times greater than it was in the depth of the depression. The repercussions of this decline were felt throughout the Canadian economy. But to the farmers directly involved, the drought not only cut off their income but dissipated their capital. Buildings and equipment fell into disrepair and farm debt rose Public services became disorganized and distress in some districts, as Fowke noted, "approached dangerously close to famine proportions".

The Value of Irrigation

11. The Commission's terms of reference in no way involved a judgment upon the benefits of irrigation as such. The Commission assumed, to start with, that the benefits of irrigation are tangible and obvious in a region of relatively light rainfall, such as the central drainage area of the South Saskatchewan River. Water is the foremost natural resource of a community existing in a land of limited rainfall. This is an enduring fact that has been impressed upon the Canadian mind by the national emergency created by drought in Western Canada during the exceptionally dry years from 1930 to 1937.

12. Measures that will strengthen the rural economy are bound to be reflected in the well-being of the country as a whole. Irrigation is one such measure. In the region between Lethbridge and Medicine Hat in Alberta, the contrast between the irrigated and the non-irrigated lands is startling. On the one hand there are well kept houses amid the luxuriant growth of gardens, fields and trees in the irrigated districts and, on the other, shabby farm buildings in bleak and desolate surroundings in the dry areas. Dry-farming does not encourage or sustain the community development that is visible where the land is watered by irrigation. The skilful dry land farmer, if he operates upon a scale large enough to assure his financial success, frequently is intent upon making a stake and retiring to some more congenial locality. Dry farming is subject to fluctuations of climate and prices so that its condition is aptly known as either a feast or a famine. Dry farming possesses inherent advantages of its own, but they are not the concern of this Report.

13. The South Saskatchewan River Development area is conspicuously one that suffers from low natural precipitation. Its need for irrigation can be established if reference is made to the main agronomic features of the Project area, without considering the cost and other factors which the Commission was required to take into account. The annual precipitation is less than 15 inches, and the effective precipitation is less than that because of the loss of spring run-off. A high rate of evaporation further reduces the effective precipitation. The Project area clearly would benefit from irrigation. The growing season is short, but the area has the advantage of long summer days. It can produce a variety of crops. Soil is second in importance only to water. The records indicate that the soils of the area may be classified as 25 per cent "very good for irrigation", 53 per cent "good", and 22 per cent "fair". Sub-soil conditions indicate that seepage and the distance to the water table may be controlled. Given good supervising staff, the Project area is suitable for irrigation purposes.

14. For administrative purposes, the legal "duty of water" is fixed in Alberta at 1·5 feet. This is expressed as 1·5 acre-feet for the irrigation season May 1 to September 30. The duty of water is the quantity of water required to produce the optimum growth of crops. It will vary from season to season. A duty of 1·5 acre-feet for the crops on the South Saskatchewan Project would be a safe estimate. To this must be added another 1·5 feet for transmission and other losses,

making a general duty of 3 acre-feet. The Project would require, therefore, about 1,350,000 acre-feet annually when the irrigated area reaches 450,000 acres. The reservoir with a dam at the Third Meridian could contain upwards of 8,000,000 acre-feet of which 2,650,000 acre-feet of water storage would be available for irrigation between full supply levels of the reservoir and canals. Insofar as present plans for irrigation upstream are concerned, there would be ample water left for the South Saskatchewan irrigation development.

15. For many years to come, it is likely that the system of agriculture on the South Saskatchewan Project would be of a livestock character. That means that forage crops would be grown and, supplemented with grains from nearby dry areas, fed to livestock on the farm. The crop problems of the Project would, however, best be determined after some experience on the Project itself. There are certain specialized crops which, after experience has been gained, might become very important in the crop program. It is certain, however, that forage crops, particularly alfalfa, could be grown profitably on the Project, if wise methods of irrigation were followed. Alfalfa is not only a good yielder under irrigation, but it is a valuable soil improver, and has great value in the feeding of livestock when combined with some of the grains that may be raised on the non-irrigated sections of the plains. Wheat itself is not an ideal crop for irrigation as early attempts in Alberta have very definitely shown. Lands quickly become weedy. Soil fertility is depleted for want of crop rotation. The growing of wheat under irrigation cannot compete with dry farming in areas having reasonably adequate rainfall. Another consideration is that the Project is not one continuous body of land. An irrigation project is always handled better if it is in one continuous area. Of course, this Project, if constructed, can be so built and so managed that each somewhat separate body of land would be a unit, and an independent unit, of the whole.

16. The need for irrigation in the South Saskatchewan Development area and the desirability of launching an irrigation scheme there, cannot be considered in isolation. The yardstick of cost must be applied to such a scheme and, in addition, the question of the most beneficial use of the resources available for development of the river basin should be settled. There can be no dissent from the general principle that, in the open plains region of Canada, all the water that can be stored economically should be put to beneficial use. But within that context, the demands made upon the great natural resource represented in the South Saskatchewan River Basin should be determined by the assurance that present and future benefits are commensurate with the cost.

The Problem of Palliser's Triangle

17. For the profitable and desirable utilization of land and water resources in a relatively arid drainage basin in the heart of the Prairie Provinces, the chief means must be irrigation. The driest part of the prairies is known as Palliser's Triangle, after Captain John Palliser of the Royal Engineers. John Palliser explored the Canadian prairie region between 1857 and 1860 under the auspices of the British Government. The central desert

region of the United States, he reported, extends a short way into British territory, "forming a triangle". The Canadian Government sent expeditions to the prairie region in 1857 and 1858 under Professor H. Y. Hind, the geologist and naturalist of Trinity College, Toronto. Hind's account agreed in general with Palliser's. An analysis of Palliser's and Hind's accounts of climate and agricultural possibilities in the South Saskatchewan drainage area is found later in this Report in the section setting out the historical background of economic development in the area. (Part II, Chapter 3)

18. Palliser's Triangle is a generalized concept. It is only roughly triangular in shape and the conditions encountered therein are far from uniform. Its centre consists of a hard core of drought area, or inner triangle, that is genuinely arid. This inner triangle has its vertical axis on the Alberta-Saskatchewan boundary with its base on the United States border. In extent, this hard core of drought area is not more than half the triangle of Palliser. It too possesses gradations of aridity. It comprises the last area to be settled in the southern prairies and the first districts to be abandoned. It includes the successful irrigated areas of Alberta, but not those areas where irrigation has been attempted without success. It includes the Special Areas of south central and southeastern Alberta, and all of Saskatchewan west of a line running through Moose Jaw and the big bend of the South Saskatchewan River. It includes the districts in which the problems of drought have been most severe, and the costs of drought relief and of human suffering, due to the failure of rain, have been highest. It comprises the drainage basin of the South Saskatchewan River east of a line roughly from Lethbridge to Drumheller, extending into Saskatchewan to the eastern edge of the Missouri Coteau. The Grand Coteau de Missouri, to use the earlier name, is generally called the third prairie steppe. "From the character of its soil and the aridity of its climate," wrote Hind, "the Grand Coteau is permanently sterile and unfit for the abode of civilized man". This is the "dust bowl" of western Canada, the locality which endured the worst ravages of the Great Drought of the 1930's. It comprises at least 15,000,000 acres. It includes districts in which settlement has failed. The reason for attempting irrigation in such an area would be, according to W. L. Jacobson, "because that is the only way in which that area can be used."

19. The most beneficial use to which the South Saskatchewan River could be put would be the reclamation of the arid heart of Palliser's Triangle. Yet such an objective has not been incorporated into public policy. The first irrigation projects in Western Canada were launched on the southwestern fringe of Palliser's Triangle, an area which is frequently deficient in moisture and is speculatively farmed on the prospects of the season's rainfall with varying results, but is generally suitable for dry land farming. These projects were established on the fringe, rather than in the heart of the Triangle, without regard to gradations of climate that indicate that the land most in need of irrigation lies to the east. The fact that emerges clearly in an account of irrigation development in Western Canada found elsewhere in this Report (Part II, Chapter 4), is that the problem of irrigating the core of aridity

in Palliser's Triangle has not been considered directly. Significantly, the limits of irrigable area in Alberta have moved steadily eastward towards this core during the last half century.

20. The origin of irrigation upon the fringes of the dry region, rather than in its heart, is one of the accidents of the economic history of Western Canada. The fringe areas of the dry triangle were settled for the most part before the homesteaders entered the dry region west of Moose Jaw. The inner triangle waited for settlers until a combination of demand for wheat as a result of World War I and the pre-emption policy in 1909, which allowed 320 acres to a homesteader rather than 160, made it more attractive for settlement. The fringe areas are sub-humid and semi-arid, but not truly arid. Even today, in view of the lack of climatological data tested by observations over a long period of time, it is not possible to define precisely the areas within the triangle which are in greatest need of irrigation. Such information is basic to a full understanding of the problems of dry farming and irrigation alike in Western Canada. It is fundamental to policy designed to deal with the problems of drought in Saskatchewan and Alberta.

21. While the relative need for moisture in the fringe areas encouraged the development of irrigation in them, the main determinant of the first irrigation projects in Alberta was the relative ease of diverting streams within the foothills region. Decisions were made, not on the basis of need to irrigate so much as of ease in construction of dams and diversion canals. As a result some of the earliest irrigation projects failed. They reverted to dry farming agriculture, in which they succeeded and in which they should remain, in line with a wise, national agricultural policy. Not being truly arid, the fringe areas of Palliser's Triangle are excellent dry farming areas, and in them the steady technological advance of dry farming has produced its greatest benefits. Where basic conditions have favoured dry farming, efforts to substitute irrigation farming have failed in more or less degree.

22. Experience gained in the development of irrigation in the West suggests the wisdom of proceeding with caution. An example is found in the Western Irrigation District, just east of Calgary. It was launched by the Canadian Pacific Railway in the expectation that a sufficient return would be obtained to show a profit in land values and, at least, to repay capital costs. The economic analysis supporting these expectations was incorrect. Originally the scope of the district was 219,000 acres, of which only 50,000 remain today. The remainder is tilled successfully by dry farming methods. The abandonment of so much of the original irrigable area represents a heavy capital loss. The C.P.R., in due course, wrote off substantial capital and operating losses and surrendered the irrigation works to the farmers. There are other examples of failure and loss in irrigation in Western Canada which indicate that irrigation must justify itself in competition with dry farming. "There must be a real human need for a project of this magnitude to succeed", as one irrigator said.

23. The conclusions to be drawn are:

(1) It is a fundamental error to attempt at heavy cost to persuade farmers in a region suitable for dry farming to turn to irrigation, and

(2) It is illusory to believe that farmers in an irrigation district can or will contribute

towards the costs of development anything more than a relatively modest sum, certainly no more than can be related to the increased productivity of his land.

24. In Alberta, the increased productivity arising from irrigation seems to have been consistently exaggerated. This is doubtless due to the failure to realize that economic progress in irrigation farming is limited by the growth of markets for the products of irrigated farms. This is an error in timing, an error that leaves out of account the slowness of market growth which, in the nature of things, is limited by the pace of population growth in Western Canada.

25. One of the major criticisms to be made of the South Saskatchewan River Project is that, in relation to the area of Western Canada that is truly devoid of moisture, it is a "fringe" project, with borderline climatic conditions, from the point of view of need for irrigation. Its irrigable area, lying along the river below Outlook, extends on both sides of the valley to the vicinity of Saskatoon. It extends to the edges of open prairie northward into the bordering area of the park country where the evidence of moisture is the prevalence of brush that consists mostly of small poplars. The Project would lie in a region in which the farmer would enjoy a choice of irrigating or not irrigating, as he judged the weather probabilities. Choice of one way of life and not another must depend upon personal preference. It is not a function of government in Canada to determine such preferences. Green vegetation is not necessarily a sign of a high standard of living; nor does dry farming necessarily mean a low standard. The irrigation farmer and the wheat farmer each has his place in our economy. Within the framework of these circumstances, the limits of prudence in investing public funds to irrigate the South Saskatchewan Development area must somehow be fixed.

26. One feature of the South Saskatchewan Project is that the area is already developed for agricultural purposes. It is an area of dry farming devoted mainly to cereal production. It suffered its measure of distress during the period of great drought in the 1930's. It contains excellent dry farming districts and, as well marginal areas. Its farmers cannot afford to neglect any opportunities for the conservation of water. But it is by no means an abandoned area. The development of irrigation in the Project area, therefore, cannot be considered wholly as the reclamation of lands which, without irrigation, would not be utilized.

Resources of the Saskatchewan Basin

27. The Saskatchewan River is an important natural resource of three Provinces. The political boundaries in no way coincide with the natural geographic regions. The upper regions of the Basin on the eastern slopes of the Rocky Mountains, and the western section of high, short-grass plains, lie in Alberta. That part of the Basin that includes the second prairie steppe lies in Saskatchewan. The delta region where the drainage area is narrow, lies astride the Manitoba-Saskatchewan boundary.

28. The primary developments in the Basin in Alberta are forest conservation, hydro-electric power generation and water storage, with all the major irrigation projects

located in the high plains area. Several sites for storage development exist, in addition to the reservoirs on the upper Bow River. In regard to irrigation, when existing projects are fully developed the flow of all the tributaries of the Basin south of the Bow River will be completely utilized except for winter and flood flows. Only the Red Deer and the North Saskatchewan Rivers remain for large irrigation developments, and the latter is unlikely to be developed within its own drainage area because the climate appears satisfactory for dry farming. In the central prairie region, the stream flows through deep valleys. Very large amounts of storage are possible, if the expense of constructing high dams is justified. Below this area, locations exist for hydro-electric developments but they appear generally to be marginal.

29. An examination of existing and possible future uses of the flow of the South Saskatchewan River indicates that an apportionment of the water in terms of its most beneficial use should be made. But such an apportionment can be made only in the light of a full examination of data, not all of which are available. The consumptive use of water for irrigation on the higher prairie steppes, for instance, will eliminate its use for generating power lower down. Increased storage capacity in the mountain and foothills region will assist in developing irrigation where it is needed lower down. The development of power sites in the lower reaches will subtract from the possibilities of further irrigation development higher up.

Deficiencies in Basic Data

30. The prime need for the basic data of the engineer, the agronomist, the hydrologist and the economist as a guide to future irrigation development in Western Canada is demonstrated by the mistakes of the past. Many errors and some of the losses could have been avoided if the technical knowledge of today had been available yesterday. Yet for tomorrow, much more research must be conducted in the region of true aridity in southwestern Saskatchewan and southeastern Alberta, if it is to be fully reclaimed and exploited in the national interest.

31. The Commission desires to point out that serious deficiencies exist in the fund of basic data available for the integrated development of the South Saskatchewan River Basin. Sound policies for the conservation and use of the water resources of the Saskatchewan River Basin and sound planning for their orderly development must be predicated upon two fundamental premises. The first is knowledge of the water resources in different regions. The second is the extent to which these water resources have been developed and utilized up to the present.

32. Western Canada has passed the stage where the natural, unregulated stream flows are sufficient for developmental purposes. Now the further development of large areas depends in considerable part on the extent to which water may be conserved by storage. More important than the complete use of water resources, is their equitable and efficient use. The water problems within any large basin differ from region to region and no common plan for the control and use of water in different regions will suffice. No

recommendations for an over-all water plan are possible without data on uses of water, precipitation, temperature, humidity, wind, evaporation, stream flow, quality of water, groundwater conditions, soil surveys, and topographical surveys. Without study of all phases of the many problems involved, recommendations could be unsound and might lead to economic waste. Unfortunately, fundamental data, the consideration of which is a prerequisite to an enlightened program of water conservation, still are lacking in greater or less degree in the three Prairie Provinces.

Legal and Constitutional Complications

33. The second part of the Commission's reference, namely, whether the Project represents the most profitable and desirable use which can be made of the physical resources involved, obviously requires an examination of the inter-relationship of various developments along the river. The interests of communities both urban and agricultural along the river, which exist today and which may develop in the future, are intimately affected by plans to control and develop the flow. In considering the integrated development of the river, the Commission has come to the conclusion that appropriate administrative machinery should be provided and entrusted with, among other things, the responsibility for an inventory of the basic data of the resources of the drainage basin, to make possible an over-all program of managed development.

34. The South Saskatchewan River system is the main water course of the semi-arid regions of southern Saskatchewan and Alberta. The chief hope of water conservation on a large scale in these regions must rest upon this great river, whose annual discharge is seven or eight million acre-feet of water. At the same time, the beneficial use of the entire flow of the South Saskatchewan River would not likely suffice for the arid, inner triangle. A good deal of dry country, that fully merits the best efforts of the water conservationist, lies beyond the reach of the most ingenious plans for the exploitation of the South Saskatchewan. The small projects devised or intended by the P.F.R.A. would still represent the only hope of many districts. The full utilization of the South Saskatchewan River cannot transform the entire arid area of the western plains into a drought-free and depression-proof region. Yet its utilization should be undertaken as a national obligation. Construction necessary to that end should be recognized as works to the general advantage of the people of Canada.

35. That the time has come to consider the development of the South Saskatchewan River in terms of national benefit rather than of isolated, local developments is clearly recognized by many persons who are informed on the problems of water conservation in Western Canada. Premier Campbell of Manitoba, in a letter to the Commission, referred to the effects of upstream developments upon the potential capacity of hydro-electric power sites in Manitoba, adding: "It would appear therefore that your Commission should give consideration at this time as to what responsibility the Government of Canada should accept for the integrated development of the

entire watershed." The Province of Alberta in its submission, made this observation:

> Because the conservation and best use of interprovincial streams in the Saskatchewan River drainage basin can only be attained through the regulation of the flow of the streams by storage, and because the natural and artificial storage sites are in the mountain and foothill regions of the drainage basin, it is not possible to administer the water resources of this basin in the best interests of the respective provinces except through a single administrative authority. In other words, these interprovincial streams cannot be administered in the best interests of the most beneficial use of water by the respective provinces separately.

Failure to take in hand plans for the full conservation of the water of the South Saskatchewan River for irrigation and allied purposes will invite criticism from which there would be no escape in a time of failure of rainfall in the future. The Commission had to consider, therefore, where the responsibility lies for the full utilization of the South Saskatchewan River on the basis of integrated, basin-wide development.

36. The head waters of the South Saskatchewan River are in Montana and southern Alberta and it flows into Saskatchewan where, north of Saskatoon, it joins with the North Saskatchewan to form the Saskatchewan River which flows into Lake Winnipeg, and from there by the Nelson River into Hudson Bay. Prior to 1930, the Crown in the right of Canada exercised sole legislative and administrative control over this and other resources in the three Prairie Provinces. In that year the administration of these resources, formerly held by the Crown in the right of Canada, was transferred to the Crown in the right of the provinces concerned. This transfer resulted in a single administration being replaced by a divided administration. Of this situation, D. M. Stephens, formerly Deputy Minister of Mines and Natural Resources of Manitoba, has said: "I think it is safe to say that the co-ordinated development of the water and related resources of the Saskatchewan River watershed represents one of the most important and one of the most complex problems in the field of resources management with which Canada is faced today. There are two national governments, three provincial governments, one state government and literally hundreds of municipal governments, each having its own general or special interest in the Saskatchewan River. There are at least six separate and distinct geographic regions each with its separate and distinct problem and possibilities relating to the control and use of water, not all of which are by any means compatible with all others."

37. The Commission is advised that development in the manner desired of an interprovincial stream like the South Saskatchewan River involves the solution of complex legal problems and problems of jurisdiction about which at present there is considerable uncertainty. While the Commission's reference does not include the making of suggestions to solve these problems, the Commission desires to point out that legal and constitutional difficulties exist. These problems are not only legislative difficulties arising from divided jurisdicton. As the Alberta submission argued, it would be difficult to administer the water resources of the Basin properly without a single administrative authority in charge.

38. The transfer of the natural resources to the Prairie Provinces in 1930 represented the fulfilment of national policy and the

achievement of Western Canadian aspirations in that regard. Yet that event left a vacuum in policy with respect to interprovincial rivers. The transfer meant the end of the Federal Reclamation Service, with a long and honourable record of water engineering, and the beginning of water conservation policy on a provincial scale. It opened the door to conflict among the provinces over a river such as the Saskatchewan, in which each province's interest may differ but in which development in one province may be of vital concern to others. The Commission feels that the conflict that is largely incipient today could harden and endanger the harmony in provincial relationships that is essential to the future economic development of Western Canada.

39. Within five years from the transfer of administrative control of the natural resources to the Prairie Provinces, the Federal Government felt that some special action was required for the relief of the people in those provinces. Parliament, therefore, enacted the Prairie Farm Rehabilitation Act which created an agency within the Federal Department of Agriculture to implement policies which involved, among other things, the development and promotion of water supply and land utilization. The P.F.R.A. has enjoyed conspicuous success in its water conservation programs.

40. The Province of Saskatchewan, formed in 1905 and having assumed administrative responsibility for its water resources in 1930, has recently organized a Conservation and Development Branch which has organized 45 water users associations, irrigated 50,000 acres, constructed 145 miles of ditch, developed 475,000 acres of dry land projects and improved the drainage in 1,000,000 acres. The Federal Government's efforts to assist Saskatchewan in dealing with the basic problem of climatic fluctuation by the beneficial use of water and improved land use, under the Prairie Farm Rehabilitation Act, have resulted in irrigating 125,000 acres in 168 projects in the Province, and a further 10,000 acres were being developed in 1952. In total, the P.F.R.A. work in Saskatchewan is represented in 31,361 small projects and 168 community projects. Those associated with this work regard the present stage of development of small water projects in Saskatchewan as perhaps half completed. There is considerable work of this kind still to be done. It is desirable to avoid duplication of effort. There is a shortage of engineers and other trained technical experts. The conditions of co-operation in this field are difficult. Responsibility for land use is exclusively provincial, yet the consequences of failure to achieve the most beneficial use of land and water throughout the arable regions of Canada create many problems of Federal concern.

41. Many agreements have been concluded between the Federal Government on the one hand and each of the four Western Provinces on the other, to carry out recommendations made under the Prairie Farm Rehabilitation Act. In no instance has a question arisen regarding the rights of another province, until the South Saskatchewan River Project.

42. The Prairie Provinces Water Board was established on July 18, 1948. It is apparent that the functions of the Board are advisory. Its members are public servants employed by the various interested govern-

ments. Its proposals become effective only after each of the governments who are parties to the agreement implement the recommendations. Each government therefore has a veto power for every agreement. The members are Canada, Manitoba, Saskatchewan and Alberta. An application by the Government of Saskatchewan concerning an allocation of water for the South Saskatchewan Project is currently in the "Reservation Class" of the Board, that is, it has not been decided.

43. There is disagreement on the Prairie Provinces Water Board and among the governments who are members of it as to the function of the Board. The extent of the disagreement was called to the attention of the Commission by the Province of Alberta, in its written submission. There is no unanimity on the question whether or not the cost of a given project should be the concern of the Board. There is equally no unanimity whether or not economic factors involved in a given project should be considered by the Board. Decisions of the Prairie Provinces Water Board have been made, in line with the authority of the Board, on the basis of water supply. The Board has considered specific projects without reference to the general requirements for water throughout the Prairies as a whole, or to the interests of the country as a whole.

44. The terms of reference of the present Commission, which was established on August 24, 1951, involve considerations which have not been raised previously in connection with water conservation policy in Western Canada; that is, whether benefits are commensurate with costs and whether a specific project represents the most profitable and desirable use which can be made of the resources in question in the interests of the Canadian people as a whole.

45. Any works erected on the South Saskatchewan River for irrigation, storage or power purposes within its jurisdiction by one province may affect the supply of water in the other two provinces if it interferes with the natural flow of the stream. The exercise of exclusive jurisdiction by any province through which the river flows might, therefore, interfere with the property rights in the river system of the other provinces. The consequent necessity for co-ordinated use of the waters was recognized by the creation of the Prairie Provinces Water Board and that necessity is now asserted by the Provinces of Alberta and Manitoba. It follows that a major project such as the proposed South Saskatchewan River Development must have regard to the rights in the river system of interested parties in Alberta and Manitoba.

46. The main considerations which seem appropriate to the development of an interprovincial river such as the Saskatchewan are:

(a) The fact that the river system is a single stream upon which property rights in each province should be respected.

(b) The duty of each provincial authority to exercise its rights reasonably and in a manner calculated to conserve the common supply of water.

(c) The rights already acquired by prior appropriation of waters of the river system in each of the provinces.

(d) The future development of the river on the basis of its beneficial use to the people of Canada.

(e) The rights of the Federal Government commensurate with its financial participation in the full development of the river system.

(f) The administrative problems involved in assuring to the people of Canada the best utilization of the resources of the river Basin.

47. The principles upon which development of an interprovincial river should be based, may be defined briefly. Development programs should be planned in accordance with the beneficial use of such a river in the interests of the people of the Prairie Provinces and of Canada. They should take account of prior allocations of water so that existing uses of the river may be protected. Between provinces there should be equitable apportionment of the flow of the river. If a river system is to be developed on the principle of its beneficial use to the people of Canada, an equitable apportionment does not mean an "equal division" of the waters, but an apportionment having due regard to the best use from a national standpoint of the resources of the drainage basin.

The South Saskatchewan River Project

48. The origins of the South Saskatchewan Project may be found in the somewhat vague and often conflicting concepts which have persisted in kindling the imagination of men who have stood on the dry benches of the South Saskatchewan River valley and have noted the juxtaposition of wide, dry lands and an abundant seasonal flow in the stream below. Such concepts are not subject to strict tests of feasibility and desirability. The first proposal to harness the river was made by Professor Hind nearly a century ago. His interest was in transportation rather than agricultural production. Hind reported to the Legislative Assembly of Canada in 1859 that a dam built at the elbow of the South Saskatchewan high enough to spill the river flow into the Qu'Appelle River valley, would provide a steamboat route for settlers from Fort Garry to the foothills of the Rocky Mountains. William Pearce, the explorer and early land surveyor, first suggested a diversion of the Red Deer River in order to carry water across Alberta and into Central Saskatchewan for livestock and other purposes. Surveys and estimates of the William Pearce Scheme were made in 1920, but they showed the scheme to be expensive.

49. Studies related to the utilization of the main stem of the South Saskatchewan River were begun by the P.F.R.A. in 1943. The proposal to construct a dam across the river in the vicinity of the elbow was revived by the P.F.R.A. in 1947, and since that time intensive research into the Project has been carried on. The main motive in the preliminary investigation into the South Saskatchewan River Project was to find ways to irrigate on a large scale in Saskatchewan as well as in Alberta. Pursuing the hope of finding alternative ways of irrigating at least part of the land in Saskatchewan associated with the Pearce scheme, the P.F.R.A. began investigations into the possibilities of a diversion on the South Saskatchewan River. The first surveys were directed at the reach of the river in the vicinity of the Cabri Ferry, above the elbow, with the intention of utilizing the White Bear depression. This would bring land

between Elrose and Saskatoon and east of Rosetown within reach of the river. But further surveys indicated that the lands suitable for irrigation were not as extensive as first believed, that suitable lands to the east and south of the river could not be reached, and that valuable lands in the neighbourhood of Lacadena would be submerged. Moreover, foundation conditions for a large structure, though hardly satisfactory anywhere along this section of the river, seemed particularly poor at the Cabri site. Investigations, therefore, were concentrated lower down the river, and since 1947 they have been confined to the site at the mouth of Coteau Creek near Outlook.

50. A description of the South Saskatchewan River Project in considerable detail will be found elsewhere in this Report. (Part II, Chapter 6.) For the purpose of considering the general features, a brief account is given here. The Project is designed to provide for the irrigation of 455,000 acres of land in Central Saskatchewan. It would also provide four secondary benefits:

(a) a source of hydro-electric power for a province-wide transmission system;
(b) a source of rural and urban water supply;
(c) stream and flood control; and
(d) recreation facilities.

51. The essential works required are:

(1) The creation of a reservoir by the construction of a dam on the South Saskatchewan River, 18 miles upstream from the town of Outlook. A second major dam is required on the upper Qu'Appelle River Valley in the vicinity of the Third Meridian. The main dam would require an extension across the mouth of Coteau Creek. In addition, it is proposed to provide a railway crossing on the Moose Jaw-Outlook line, involving a substantial earth fill.

(2) The construction of the irrigation canal distribution system, with pumping facilities where required.

(3) The construction of a hydro-electric powerhouse.

52. The four large earth structures—the Main Dam, the Coteau Creek Dam, the Third Meridian Dam and the railway crossing—would require a total of 57,500,000 cubic yards of material, most of which can be obtained in the vicinity. The dam would be 205 feet high with a crest length of more than 8,000 feet from bank to bank. It would impound about 8,000,000 acre-feet of water, of which 2,650,000 acre-feet would be live, or useful, storage. The reservoir would extend 140 miles upstream on the South Saskatchewan River and 30 miles down the Qu'Appelle River Valley to the Third Meridian. The reservoir would have a surface area of 116,000 acres and a shore line of almost 500 miles. It would inundate about 70,000 acres of land of which 11 per cent is under cultivation.

53. The irrigable lands are located on both sides of the South Saskatchewan River in the section extending from Elbow to the vicinity of Saskatoon. In addition, an irrigable area of about 24,000 acres exists along the valley of the Qu'Appelle River.

54. The Project would involve the relocation or abandonment of the Canadian National Railways line from Central Butte to Dunblane as the river crossing at Elbow would be flooded out. A portion of the Canadian Pacific Railway line from Moose Jaw to Outlook would have to be raised.

55. At least six years would be required for construction of the main works, after preliminary steps were taken. In the early stages of construction, considerable latitude would be possible in the amount of work undertaken in one season, but definite minimums of work would have to be completed at critical stages, such as the closure operations. Work on the irrigation system could be planned to start three or four years after commencement of construction of the reservoir.

56. No water would be available for irrigation until the dam was practically completed. The construction of canals could be timed to suit the demand for irrigated land, or other conditions. A reasonable program would be first to irrigate all lands that could be reached by gravity. These lands could be irrigated in the season when the dam was completed. In the main area (excluding the Qu'Appelle River Valley) the irrigable lands of 454,950 acres include, according to the P.F.R.A., the following:

	Acres
By gravity	179,800
Pump lift 15 ft.	45,750
30 ft.	70,400
60 ft.	80,400
120 ft.	78,600
	454,950

57. The demand for power for pumping water would be a first claim upon the output of the power plant. This demand would increase as the Project developed. Twelve large pumping stations would be required. Upon full development of the irrigation system, pumping would require 50,000,000 kilowatt hours of energy, with a maximum demand approaching 40,000 kilowatts.

The Estimate of Cost

58. The preparation of an estimate of cost of the South Saskatchewan River Project was regarded as a fundamental step by the Commission, in dealing with its terms of reference which required it to inquire whether the economic and social returns to the Canadian people on an investment in the Project would be commensurate with the cost. Several estimates of cost had been prepared. They had been based upon the engineering studies made by the Prairie Farm Rehabilitation branch of the Department of Agriculture. These studies were supplied to the Commission in a single large volume, the General Engineering Report. This report represents the expenditure of many hundreds of thousands of dollars of investigatory work carried out over a period of years, and is still subject to alteration and enlargement. The Commission did not review the basic engineering studies of the P.F.R.A., except to confer with the senior engineering consultants of the P.F.R.A., namely, Major General H. B. Ferguson, Washington, D.C., Dr. Arthur Casagrande, Boston, Mass., and L. F. Harza, Chicago, Ill., on certain aspects of the Project wherein the engineering difficulties were obvious and which would influence the cost. This conference was held in Washington, D.C., in April, 1952, and as a result the Commission decided to obtain an estimate taking into account the views of the senior consultants and, as far as possible, the experience of firms engaged upon comparable construction projects.

59. In preparing an estimate of cost, the Commission relied upon the General Engineering Report on the Project supplied by the

P.F.R.A. The estimate was prepared for the Commission by Mannix Ltd. of Calgary, Alberta, which availed itself in turn of the experience and professional knowledge of a number of United States firms which have been engaged directly for a number of years on large engineering projects comparable in scale, if not in precise detail, to the South Saskatchewan Project. Notable among these firms were Morrison-Knudsen Co. Inc., Boise, Idaho, a firm which is one of the prime contractors on the $290,000,000 Garrison Dam project on the Missouri River, which is comparable to the proposed Coteau Creek Dam, and International Engineering Co. Inc., San Francisco, California. The Commission feels confident that it obtained the best study of cost of the project that can be made on the basis of data available.

60. The following General Summary of Cost Estimate is from the report submitted by Mannix Ltd. Details of quantities and other data will be found in Part II, Chapter 7, of this Report.

Diversion, care of river and unwatering working places	$ 2,821,000
Main dam	19,971,230
Conduits and intake	25,179,005
Powerhouse area	2,054,695
Powerhouse and switchyard	16,354,350
Spillway	10,687,400
Coteau Creek dam	1,630,335
Third Meridian dam	4,721,650
Elbow Railway crossing	5,242,255
Railway relocation	2,857,690
Cement	8,368,365
Operators' village	300,000
Road relocation and bridges	3,000,000
Miscellaneous service and general plant operation	5,157,900
Land damage and acquisition	600,000
Contractors' general expense	12,301,400
Allowance for contractors' contingencies	4,000,000
Escalation of wages and materials	10,000,000
Engineering	8,000,000
Interest during construction	6,125,000
Contractors' general overhead and profit	15,000,000
	$163,772,575

61. This estimate does not include two important items:

(1) Irrigation structures, outlets and distribution system.

(2) Contingencies for any changes in design or over-run in quantities.

62. To furnish a complete figure, the cost of the irrigation system should be included, but it was omitted because the field surveys, plans and specifications were not sufficiently advanced. Preliminary and general estimates of the cost of the irrigation system had been made, however, by the P.F.R.A. The Commission decided that, in arriving at an estimate of the cost of the entire Project, allowance should be made for not less than $45,000,000 for the irrigation system. An additional cost would be 12 pumping stations, requiring an allowance of $30,000,000. A further cost would be land acquisition. This item would amount to $9,100,000. The approximate over-all cost would be:

Main works and reservoir	$139,800,000
Power Plant	24,000,000
Irrigation system	45,000,000
Pumping stations	30,000,000
Land acquisition	9,100,000
	$247,900,000

63. In summary, the estimate of P.F.R.A. made originally in 1947 and revised in 1951 in the light of changes in design and data, was:

Dam and reservoir	$ 66,460,000
Irrigation system	25,100,000
Powerhouse	13,800,000
	$105,360,000

64. Several of the major changes which have been made by the P.F.R.A. and their consultants since the original estimates were made, and which have materially increased the cost, were:

A. It was decided, at the meeting of senior consultants on the Project arranged by the Commission in Washington, D.C., in April, 1952, to recommend a steel lining of 1¼ inches thickness in the three conduits between the intake structure and the powerhouse, a length of 2,750 feet. This liner would require 33,000,000 pounds of steel plate, at an estimated direct cost installed of $11,200,000.

B. It was also decided to use Kalicrete concrete rather than ordinary Portland cement, on which the P.F.R.A. estimate was based. This would increase the direct cost by approximately $1,273,000.

C. The design of the left embankment trim was altered from a structure requiring 2,113,000 cubic yards of fill to 6,316,000 cubic yards of excavation.

D. The layout of the conduits and spillway outlet channel was revised and this increased the quantities required.

65. Some other factors which have increased the cost over previous estimates were:

A. Riprap. The other estimates proposed using field stones from various areas in Central Saskatchewan. Mannix Ltd. did not regard this as practical, nor did they feel that it could be done for $3.50 per ton ($4.20 per cu. yd.). Mannix Ltd. based their estimate on bringing rock from the Frank Slide in Alberta, at a direct cost of $11 per cu. yd. They estimated the total amount of riprap required to be 702,000 cu. yds. Based on this quantity, the estimate would be $4,774,000 higher than P.F.R.A.'s estimate.

B. Power Plant. The P.F.R.A. estimated the total cost of a power plant to be $13,800,000. Mannix Ltd. estimated the direct cost to be $18,409,000, an increase of $4,609,000. Addition of an appropriate share of the total overhead and other indirect costs to the direct cost of the power plant would allocate $24,000,000 of the total cost of the Project to the power plant.

C. Mannix Ltd. included allowance for road relocation, general plant operation, contractors' general expense, escalation of wages and materials, engineering, interest on financing during construction, and contractors' overhead and profit, which total $58,709,300. Information at hand did not indicate what amounts, if any, had been used for these items in the two previous estimates.

66. It should be noted that the plans for the South Saskatchewan River Project are preliminary in nature. They were prepared by the P.F.R.A. for the purpose of determining the scope of the work, and they were not always in agreement with each other. "The intent of the plans", Mannix Ltd. advised the Commission, "was clear and we have reconciled whatever differences we found with the firm intention to build a good job. Where

details were not found on the drawings, we have supplied them, where possible, from our own experience." As no detail on the powerhouse was provided, use was made of a power plant which was designed recently and has the same operating characteristics as the plant proposed for the South Saskatchewan Project, to obtain the necessary list of items and prices for this estimate.

67. The basic wage rates obtained for the estimate are those currently in effect in Saskatchewan and did not include any penalty for working labour beyond 40 hours per week. In regard to wages, the Commission was advised by Mannix Ltd. that they regarded these rates to be low, but found it difficult to estimate the amount by which they should be increased, having no information as to the year in which P.F.R.A. might be authorized to start work on the Project. For the same reason, it was difficult to forecast increases in cost of materials although they would likely be substantial. To provide for escalation in labour and materials, the estimate allowed $10,000,000 "which might be a realistic guess should the Project be started within two years".

68. The estimate included an estimated contractors' performance bond cost of $375,000 which is in accordance with present rates, but is not a firm figure since the contract terms which might be contemplated were not known.

69. Mannix Ltd. included an estimate of cost of railway relocation over the Elbow Crossing and main dam in accordance with the owner's project report. A preliminary reconnaissance and estimate on the same basis indicated a possible savings in excess of $2,000,000 by a crossing over the Third Meridian Dam instead of at Elbow Crossing. A study of this alternative crossing was recommended.

70. An allowance of $3,000,000 was made for re-routing highways around the reservoir area.

71. Mannix Ltd. reported: "We are aware that P.F.R.A. has certain arrangements for engineering on this project, and that considerable monies have been spent to date. We have no information concerning these arrangements or expenditures. We have allowed $8,000,000 for this item, which will include project design and owner's inspection and other costs properly allocable."

72. The estimate included an allowance of $6,125,000 for interest on financing during construction, based on $25,000,000 a year for seven years at 3½%.

73. The estimate contemplated a minimum construction schedule of six years, with a diversion in the fourth or fifth year. These six years would be over and above the estimated six months required to build access roads and set up camps. It was also based on the assumption that all work in the main dam area would be let as one job to one bidder. It was felt that considerable saving would be realized by this procedure in eliminating duplication of supervisory job personnel, contractors' facilities, move-in costs and equipment. A longer construction period with additional cost would be required if the job were let in several separate contracts.

74. In order to furnish a comparison with and a test of estimates of the South Saskatchewan River Project, the Commission obtained a summary of the current estimate (July 1952 prices) of the Garrison Reservoir

Project on the Missouri River. The total was $289,854,000, but the details concerning present project cost estimates were not available for public release.

Cost of Pumping Water to Land

75. One of the costly features of the South Saskatchewan River Project is the requirement to pump water to three out of five acres in the planned irrigable area of 454,950 acres. Blocks amounting to 179,800 acres could be irrigated by gravity, the remainder requiring pump lifts up to 120 feet. Little irrigation by pumping water has been carried on in Western Canada in the past. Opinions expressed to the Commission by experienced irrigators indicated that pumping costs would be an unwelcome addition to operating expenses. The question would have to be decided, if the Project were proceeded with, whether or not the cost of pumping water should be charged to the Project, rather than to the individual farmer.

76. It was assumed that power, delivered at the pumping stations, would cost $20 per year per h.p. of maximum demand. At this rate, the cost per acre for power only to pump water to various sections of the irrigable area is shown in the following tabulation:

Pump lift	Cost per acre
15 feet	$0.78
30 feet	1.57
60 feet	3.13
120 feet	6.27

The weighted average of these costs is $3.07 per acre of area requiring pumping, or $2.07 per acre throughout the entire Project. Upon adding the cost per acre for power to the estimated cost for operation and maintenance of the irrigation works including pumping plants, at say $2 per acre (based on the average cost for existing projects), a total of around $4 per acre per year is reached, or double the amount that the irrigation farmer expects to pay in Alberta projects.

77. For purely administrative reasons, it may be suggested, the Saskatchewan authorities entrusted with the management of the South Saskatchewan River Project would likely decide that the simplest procedure would be to charge the cost of pumping water to the Project, that is, to the taxpayers of the Province. One other possibility exists, namely, to obtain the power required to pump water from the Saskatchewan Power Corporation, i.e., at the expense of the power consumers of the Province. The schedule of colonization of the Project, envisaged in preliminary plans, calls for settlement of the areas irrigated by gravity first. The decision would have to be made at the outset whether the costs of pumping would be spread evenly over the entire irrigable area. If the decision were to do that, the farmer whose land requires no pumping would doubtless regard a pumping charge as an imposition upon him. Yet if the land to which water would have to be pumped were expected to bear the pumping charge in proportion to the expense of delivering the water to it, the farmer located on land requiring a pump lift of 120 feet would face a charge of more than $6 an acre. This would make his annual maintenance and operating costs around $8 an acre. Such a charge is far more than a farmer in such circumstances could pay.

78. It should be pointed out that the degree to which pumping of water would be required to bring the South Saskatchewan

River Project to full development is excessive in relation to existing irrigation developments in Western Canada. The pumping requirement raises doubt whether the high-lift areas would be utilized in the foreseeable future. This is a matter of concern to the Commission, in view of the likelihood that the irrigable area would turn out to be considerably smaller than anticipated, as a result of a possible decision in the future to curtail the Project, leaving unattractive, high-lift blocks undeveloped.

79. The South Saskatchewan Project has introduced the question of pumping water to dry land, as a new element in irrigation policy in Western Canada. Recent discoveries of oil and the possibilities of new economies in the exploitation of extensive coal deposits suggest the advisability of definitive studies of the cost of power for pumping as a means of extending the limits of irrigation in the future. Of particular value in this connection would be studies of the feasibility of introducing irrigation schemes in Palliser's Triangle. The maximum use of the South Saskatchewan River for irrigation purposes in the future will depend upon economical pumping of water.

Recovery of Costs

80. Another feature of the Project is that the capital costs would not be recovered in any degree that can at present be foreseen. The division of costs on large irrigation projects was determined by P.C. 2298, June 19th, 1947. A capital investment of some $140,000,000 in the main works of the Project would be borne by the taxpayers of Canada, and would not be recoverable. The canal distribution system and pumping facilities would be provided by the Province of Saskatchewan, and the degree that these costs, along with the cost of land acquisition, amounting to about $85,000,000, would be recovered would depend upon policies adopted by the Province. In Alberta's irrigation developments the purchase price for a water right has varied for different projects from $10 to $20, and has been fixed recently for the St. Mary River Project at $10 an acre, payable over a period of years. The annual rate for operation and maintenance averages for all projects approximately $2 an acre. There would be, therefore, virtually no recovery of capital costs, except with respect to the power plant, which is estimated to cost $24,000,000.

Immediate Effects upon the Economy

81. The cost of the construction of the South Saskatchewan River Project in current prices has been estimated at $247,900,000. The impact of such an expenditure upon the economy may be analysed by relating it to the total volume of similar expenditures that are currently being made in the economy and the region. The real cost to the community of any specific investment is measured by the amount and value of other goods and services that it must deny itself in order to make the investment. With relatively full employment, no new physical assets can be created without diverting labour and other resources from their current employment. Society must then do without the production that is lost by this transfer and this represents the real cost to it of the Project. When labour and

other resources have no employment opportunities they can be utilized for the production of goods and services which thereby are secured without any real cost to the community. This is one aspect of the argument that the best time for heavy investment of public money is during a period of business recession.

82. If construction were completed in eight years, as originally contemplated, the main works would involve annual expenditures of about $17·5 millions during the first five years, rising to about $32 millions in the seventh and eighth years when the power plant and irrigation works were begun. In comparison with these amounts, the value of new construction in the Prairies in 1951 was $499 millions, with $196 millions of this total spent on engineering construction of all types. Government expenditures on engineering construction in the Prairies were $83 millions, or about 40 per cent of all expenditures of that kind. For the country as a whole, the value of engineering construction in 1952 was forecast at $1,071 million. Since mid-1950 the costs of construction have been rising rapidly. It is difficult to evaluate in money terms the effects of a new project as substantial as the South Saskatchewan River Project upon the national economic welfare, and to determine whether or not employment conditions would be such that it would enlarge the inflationary pressures upon the economy. Government policy, however, at the present time is to postpone public construction projects that can be deferred on the grounds that the current high level of investment demand is an important factor in the prevailing inflation. Under present conditions, public investment adds to the pressure upon the price level. Construction of the project should be considered only in relation to its timing in such a way as to *minimize* its real cost and to avoid increasing inflationary pressures in the economy.

83. The major material requirements for the Project are the various types of earth fill. These are available in quantity at the proposed site, as are aggregates required for the concrete. The rock required for riprap may have to be brought from the Frank Slide in Alberta. There is no problem in its supply. The Project would require about one million cubic yards of concrete. The cement would be supplied from the Exshaw, Alberta, and Winnipeg plants, having a combined capacity of 17·6 million bags per year by 1953. The largest annual requirement would be 2·5 million bags, and officials of the industry indicate that given advance notice, this amount could be met without affecting the price of cement. Three types of steel are required; reinforcing steel, steel plate and structural steel. In terms of domestic capacity, the demand for reinforcing steel represents a very small portion of annual output. The demand for steel plate in the two years during which it would be placed is only about five per cent of present capacity. The structural steel is of standard sizes and the requirements are relatively small. The three types of steel are produced in the central provinces and, with respect to fabrication, there is ample plant capacity in the Prairie region except for steel plate, which would have to be fabricated in Montreal.

84. Construction firms engaged in earth moving projects are among the most mechanized enterprises in the construction field. It is estimated that about $10 million

of equipment would be used on the site of the Project, with about $5 million worth assembled at the outset and maintained throughout the job. Certain heavy items would have to be imported from the United States, representing the only major leakage to import markets of the total expenditure for the Project. These requirements represent a relatively small proportion of the annual expenditures on this type of machinery and equipment.

85. Of all the factors required, labour emerges as the only one in critical supply. There is not a large group of construction labourers in the Prairie region and, at the present time, these are fully employed during the construction season as construction activity and resource development are maintained throughout the area. The construction season coincides with the seasonal demand for farm workers. Some difficulty of assembling the necessary labour force and some pressure on wage rates would likely be encountered if the Project were initiated under present conditions.

86. Since the real cost of the Project depends upon the conditions of employment for the economic resources it requires, it is evident that such cost would be heavy at the present time when Canadian resources are relatively fully employed. It is a public Project of very slow fruition and one which will have an indefinitely long life following its development. Variation within a period of a few years in the date of its completion would not greatly affect the value of its yield. Consequently, timing its construction to minimize its real cost would maximize the net benefit or return to the Canadian people. The best timing for the Project would be a period of slackening employment.

The Direct Economic Benefits

87. In considering whether the economic and social benefits of the South Saskatchewan River Project are commensurate with the cost, the Commission was entrusted with an undertaking in economic analysis for which the techniques of measurement are not fully developed. The benefits of the Project are the primary and direct returns obtained from farm production and a number of other benefits. These include the generation of hydro-electric power, the provision of municipal and industrial water supply, stream and flood control, and recreational facilities.

88. Primary and direct returns arise from the creation of irrigated land and its productive use. These returns are easily identified and they are measurable in the same way that returns on private investment are measurable through calculations of future events. The margin of error in measuring the direct benefits of irrigation is somewhat larger than in most investment opportunities only because the time of construction, colonization and development is so long that assumptions regarding future prices and costs may be proven wrong. The projection of price levels in such a case, as the Saskatchewan Government warned, is "extremely hazardous". A study prepared for the Commission by Dr. K. A. H. Buckley of the Department of Economics, University of Saskatchewan, included estimates of direct returns to show several variants. (Part II, chapter 8.)

89. The time lag between construction of an irrigation project and its full development is of paramount importance in appraising the economic benefits. Production experi-

ence in irrigation farming in Western Canada shows that the evolution of a project involves three stages:

(1) A developmental stage of about five years in which water use and basic practices are being established.

(2) A transitional stage in which land and water uses are improved and crop specialization is established. In Alberta this stage has often involved two generations of irrigation settlers and periods of 30 to 50 years.

(3) The mature stage, in which the full effective use of water is established. This stage can hardly be reached before the year 2000 in the South Saskatchewan Project, if started in the next year or two.

In an agronomic sense, the different stages may be seen in the existence of three types of farms in the irrigated areas, namely, the wheat-cereal farm, the mixed grain and livestock farm, and finally the specialized farm producing the most valuable crops that can be grown in the Western Canadian irrigated areas, such as sugar beets and canning vegetables. Even at maturity, an irrigation project in Western Canada cannot be expected to be devoted entirely to specialty crops. In fact, the feed and livestock type of farm may represent the most desirable development for most of the available irrigated acreage, if optimistic forecasts of Canadian meat requirements for domestic and export markets are fulfilled. In the South Saskatchewan drainage area today, where irrigation has been practiced on an increasing scale for half a century, the irrigated area amounts to more than 610,000 acres. Of this total, about ten per cent is devoted to specialty crops. According to forecasts prepared for the P.F.R.A., the acreage in *effective* production of high-return crops on specialty farms at the final "mature" stage of development of the South Saskatchewan Project would be 23,700 acres. In the analysis referred to, this figure has been doubled, on the ground that it is not unreasonable to assume that the future demand for food may warrant a more optimistic projection.

90. Other assumptions made are, on the whole, more optimistic than those made in earlier studies. The construction period of the Project, originally ten years, was reduced by the P.F.R.A. consultants to eight years when the question was referred to them. Mannix Ltd. suggested six and a half years. Dr. Buckley's analysis assumed eight construction seasons, allowing for delivery of water for irrigation in the 1959 season. Full development of the irrigated area could be reached in 50 years, it was assumed, rather than 60 years. In regard to future prices, it was assumed that the 1921-40 average, which includes the years of extremely low prices from 1930 on, could not be relied upon as a guide to the future. Instead, the 1921-48 average would serve better, and for the purpose of comparison, 1951 prices were also taken, since the existing degree of inflation in both farm prices and construction costs is about the same. If this was an error on the optimistic side, it could be argued that an assumption based on a substantial decline in relative prices for agricultural products would eliminate the economic justification for any extension of agriculture resources in Canada at all.

91. The size of farm assumed in the earlier study included 144 irrigated acres. For the present analysis a 30 per cent increase in the size of farm at full maturity was included in

some of the projections employed in order to protect the Commission's findings against undue pessimism in its assumptions. The variants assumed in the estimate of direct returns from the irrigation project show the following results:

GROSS RETURNS PER IRRIGABLE ACRE AFTER COMMENCEMENT OF IRRIGATION

	Year 3 (initial)	Year 20 (transitional	Year 35 (mature)
At 1921-40 prices	$ 0.23	$ 1.39	$ 4.09
At 1921-48 prices	3.19	5.14	9.66
At 1951 prices	9.21	14.11	21.45

These figures are subject to deductions for annual maintenance and operating costs, and this is assumed to be $2 an acre, without pumping. However, as the South Saskatchewan Project involves pumping for three out of five acres, the average operating cost must be increased by $2 an acre, making a total of $4 an acre. The result of applying this average cost figure to the gross returns as estimated is evident. The returns if prices prevailed at the 1921-40 average would be barely sufficient to pay operating costs even at the stage of mature development of the Project. If the 1921-48 prices represent an average likely to prevail in future, the estimated returns would not be sufficient until after 20 years of progressive development to pay operating costs including pumping. These calculations do not include capital charges. If 1951 prices may be taken as the norm, estimated returns would be sufficient to repay current costs and provide net income to contribute to capital costs and to the farmer's profit.

92. On the basis of the more optimistic variants, the annual earning power of the land, or net rent per irrigable acre, may be calculated with the following results:

	Year 3	Year 20	Year 35
1921-48 prices...	$ 1.69	$ 2.84	$ 7.36
1951 prices	7.21	10.04	17.38

Ignoring the risks in projecting future prices, the net return per acre may be capitalized at the current Federal interest rate to estimate the per-acre value of irrigated land:

	Year 3	Year 20	Year 35
1921-48 prices .	$ 48.33	$ 88.22	$210.55
1951 prices ...	206.21	287.14	497.07

In terms of the entire irrigable area of the Project, the estimated land values in millions of dollars are:

	Year 20	Year 35
1921-48 prices	$ 37	$ 96
1951 prices	131	226

The total annual earning power in millions of dollars for the entire area is as follows:

	Year 20	Year 35
1921-48 prices	$1.3	$3.4
1951 prices	4.6	7.9

These values show the share of the over-all cost of the Project that may be borne by the increase in agricultural production. They are subject to a deduction for the value of the same land in its present use for dry farming production. In its present use the land in the irrigable area is currently valued at about $20 an acre, that is, $9,100,000 for the irrigable area.

93. Deducting the most optimistic estimate of the value of the power plant ($30,000,000) and the saving with respect to municipal water supplies ($4,000,000) from the total cost of the South Saskatchewan River Development leaves a remaining cost of $214,000,000. Some part of this $214,000,000 will be offset by the direct

returns to irrigation. The remainder, that is, the deficit after deducting the irrigation returns, represents the cost to the people of Canada of the various indirect economic and social benefits associated with the Project. The annual interest costs on $214,000,000 at the present Federal, long-term interest rate (3½%) is $7,490,000. On the basis of the projection of 1921-48 prices, the annual deficit would be approximately $6,200,000 in Year 20, and $4,100,000 in Year 35, at which level it would presumbaly remain indefinitely. The accumulated interest deficit, ignoring compound interest, would be $190,000,000 in Year 35. On the basis of the projection of the 1951 prices, the deficit would be approximately $2,900,000 in Year 20, zero in Year 33. After Year 33 an annual surplus of $400,000 would emerge. Again ignoring compound interest, the cumulated deficit in Year 33 would be $109,000,000.

Hydro-Electric Power Values

94. The development of hydro-electric power at the South Saskatchewan Dam has been an ancillary objective of the Project since the first engineering studies of it were prepared. The *Interim Report* of May 30, 1947, said: "The primary use of this Project is, of course, for irrigation". This report provided for the ultimate installation of 119,500 h.p., developing 416,000,000 K.W.H. of electrical energy annually for sale in the initial stages of development At full development, the power capacity required for pumping was estimated to be 87,300 h.p. At that stage, 210,000,000 K.W.H. annually would be available for sale. "It is evident," the report said, "that power will be an important factor in this development." Another report, in November, 1949, assumed that the installed capacity would be 150,000 H.P., that 400,000,000 K.W.H. annually of firm energy would be available in addition to the energy needed for pumping. This report added: "The output would drop to about 300,000,000 K.W.H. during periods of low flows." Subsequently, Professor David Cass-Beggs, of the University of Toronto, prepared a report on power aspects for the Saskatchewan Government. The estimate put forward by J. W. Tomlinson, chairman of the Saskatchewan Power Corporation, in January, 1951, was a compromise of the figures of the P.F.R.A. and Cass-Beggs. Mr. Tomlinson's estimate assumed that the power plant would produce 250,000,000 K.W.H. annually of firm power, worth 5·5 mills, and 75,000,000 K.W.H. of secondary energy worth 3 mills. These values would produce $1,600,000 gross revenue annually. The *Summary Report* of the P.F.R.A., April 1951, assumed that capacity of 150,000 h.p. would be installed, and the plant would produce 375,000,000 K.W.H. annually of firm energy. This would be subject to deduction of 50,000,000 K.W.H. required for pumping, at full development, giving 325,000,000 K.W.H. of commercial energy. In addition, there would be 100,000,000 K.W.H. of secondary energy. These figures were adopted in the Interim Statement submitted by the Government of Saskatchewan on April 30, 1952. Values were placed upon the estimated power of 5·5 mills for firm energy and 3 mills for secondary energy, providing gross revenue of $2,237,500 annually at full development.

95. Pertinent estimates regarding the power plant are that it would cost $24,000,000 and the operating costs, excluding capital charges, would be $1,200,000 a year. If the resultant net incomes from power are capitalized at four per cent—the current long-term interest rate of the Province of Saskatchewan—the capital value created by the power project, as estimated for the purposes of the Saskatchewan submission, would be $29,062,500 in the first year of operation of the plant. This would decline to $25,937,500 in Year 20. These figures may be regarded as the share of the over-all cost of the Project that may be credited to the power development.

Municipal Water Supply

96. The improvement of municipal and industrial water supplies is an important, though secondary, feature of the Project. The cost to the Federal Government, under the commitment to maintain the level of Buffalo Pound Lake as a water supply for Regina, Moose Jaw and other municipalities, would be reduced if the lake level were controlled from the South Saskatchewan reservoir rather than by pumping from the South Saskatchewan River. An annual pumping charge of $150,000 would be eliminated. This represents a capital sum at 3½ per cent of $4,290,000. This sum may be regarded as a credit to the Project, offsetting the cost.

Other Benefits

97. The South Saskatchewan Project would facilitate the control of the natural flow of water in the river, consequently improving the potential power sites and reducing the danger of flooding downstream. These are real though intangible benefits for the most part, impossible to measure in financial terms. It is evident from the *Summary Report* of the P.F.R.A. that a considerable improvement of the water flow and of the quality of water in the Qu'Appelle Valley would result from the Project on the South Saskatchewan River. At flood stages of the river, there is recurring danger of flood damage south of Saskatoon and at the city itself. In addition, the useful development of delta land in the lower reaches of the main Saskatchewan River, both in Saskatchewan and Manitoba, will require all the advantages of flood control that can be reasonably obtained. Yet flood control, as the Province of Saskatchewan asserted, does not lend itself to accurate dollars-and-cents measurements. It is not possible to make an estimate of the value of flood control resulting from the Project.

98. The improvement of potential power developments downstream from the main reservoir of the Project should result in an increase in the recovery of energy. Calculations to this effect have been submitted by the Province of Saskatchewan. The Commission feels, however, the accompanying data were hypothetical and insufficient as a basis to evaluate the effect of the main reservoir upon sites at Fort a la Corne, Nipawin, Squaw, Batoche, Coxby, Dauphin River and the Nelson River. Some of these sites are probably marginal, and would remain uneconomic in spite of an improved flow. The results of control of the river, moreover, would have to be considered in relation to the loss of energy resulting from depletion,

or consumptive use, of the flow by the irrigation of land. The view of Manitoba was expressed in these words: "It is quite possible that this Project could cause a serious decline in the potential capacity of the power sites on the Dauphin and Nelson Rivers." D. M. Stephens, formerly Deputy Minister of Mines and Natural Resources in Manitoba, pointed out, in an analysis of Manitoba's water problems, the risk "that a drastic reduction of flow in the low water years might very easily change the Dauphin River scheme from an economic to an uneconomic undertaking". The direct loss to Manitoba of diversions from the Saskatchewan River, which have been proposed for irrigation purposes, would amount to 440,000 firm horsepower, according to Stephens. Such a loss would be felt severely in Manitoba, where alternate sources of power are lacking. The Commission recommends therefore that the engineering studies required to evaluate the downstream effects of river development should be undertaken.

99. Income benefits to dry land producers associated with the Project, though indirect, would be of considerable importance, especially at a time of general drought in Western Canada. The neighbouring territory would furnish to the Project a supply of pasture, labour and equipment services. On the other hand, the Project area would serve as a source of seed, feed and farm produce and as a limited market for livestock. The Commission calls attention to the view, expressed by Professor Van Vliet, that the information required to appraise these indirect and imponderable benefits is seriously limited. An enterprise in resource development on the scale of the Project, however, would have far-reaching results throughout the region in which it is located.

100. The South Saskatchewan Project would create employment opportunities for agricultural immigrant labour, whose wages would represent an addition to the national income of the people of Canada. The settlement of the Project, however, is not contemplated exclusively as an immigration scheme. To the extent that it represented a transfer of farm labour from one type of agriculture to another that offers superior alternative employment through higher wages, the Project would provide a net gain in national income. Whether the Project represents a more desirable form of resettlement of farm population than the opportunities available in virgin lands elsewhere can be settled only by examining alternative opportunities. The Commission did not regard such an inquiry as coming within its terms of reference.

101. The indirect returns from the Project enjoyed outside of agriculture would be substantial, though difficult to measure. Expenditures in the Project area are estimated to be approximately $3,000,000 annually under dry farming conditions. These expenditures would increase three or four times, under irrigation farming. The impact of these expenditures would be diffused over a large variety of enterprises throughout the country. The same effect is achieved in relation to the irrigated areas of Alberta.

102. The South Saskatchewan drainage basin has become, on the whole, a region of declining population. The Project is one that would reduce the social and economic

costs of this phenomenon. The advantage of locating such a Project within an area of declining rather than expanding population is obvious, though it must be considered in relation to other tests of economic desirability. The capital equipment and established services available in the communities that would be affected by the Project would enjoy enhanced use if the Project were undertaken. This is one of the important though imponderable benefits to be credited to the Project.

103. The saving in farm assistance payments that would be rendered unnecessary by the South Saskatchewan Project has been estimated at $368,100 annually. This amount should be regarded as a credit offsetting the costs of the Project. Its capitalized value is $10,500,000.

104. Through an increase in production, the South Saskatchewan Project will increase the base of Federal taxation upon income. The extent of the increase has been estimated at $800,000 annually in one case, at $1,100,000 in another. These estimates, however, are subject to an important qualification in that the investment in the Project may well preclude other desirable investment which could produce a larger net income. The Commission asserts that if the Project is built under conditions of full employment, it would not necessarily produce a net increase in national income greater than the increase that would follow investment in other fields of production.

105. The social benefits of the South Saskatchewan Project are clearly discernible, though impossible to measure precisely. The number of dry land farms in the area that would be affected is 1,245, and these farms would in time be replaced by 2,700 irrigation units. The effect of more than doubling the number of farm families in the area would have far-reaching, beneficial consequences for at least a dozen towns and the City of Saskatoon. The result would be to arrest the decline in population in the region and provide the basis for closer community life. The enhancement of community amenities, of home surroundings and conveniences and the psychological stimulus gained in life in an expanding community restore vision and release new energies that are of high value. All these things follow from an assured supply of water in a dry region.

106. The recreational value of the South Saskatchewan Project is unique even in a country as liberally supplied as Canada in facilities for the enjoyment of healthful leisure. It would create new facilities for hunting, fishing, swimming, boating, picnicking, camping and summer cottage life on a scale that is not readily available to a majority of the people of the dry plains. The validity of assumptions regarding the increase in recreational facilities is amply proven by reference to similar indirect benefits from irrigation enjoyed by the people of irrigation areas in Alberta. There is one important qualification that should be borne in mind. It arises from the consequences of drawing down the water level in the main reservoir during the months in which the inflow will not be sufficient to maintain a constant level. The shoreline of the main reservoir will be subject to fluctuation, as the water level in a dry year may be drawn down 20 or 25 feet. The shore conditions may require special measures such as the creation of artificial beaches. The chief beneficiary of the Project from a recreational

point of view would likely be the Qu'Appelle Valley with its succession of lakes and Last Mountain and Little Manitou Lakes, and its established tourist facilities.

Summary of Costs and Benefits

107. A balance sheet of the benefits and costs of the South Saskatchewan Project cannot be presented owing to the immeasurability of many of its indirect effects. However, a summary of the financial position of the Project at maturity may be drawn up as follows:

Original capital cost (Year 1)	$247,900,000
ADD:	
Land acquisition (Years 1-20)	9,100,000
	257,000,000
DEDUCT:	
Capital value of power (Year 35)	26,000,000
	231,000,000
Municipal water service (Year 35)	4,300,000
	226,700,000
Relief savings (Year 35)	10,500,000
	216,200,000
ADD:	
Accumulated deficit (Year 35: simple interest, 1921-48 prices)	190,000,000
	406,200,000
DEDUCT:	
Land value of irrigated area (Year 35: 1921-48 prices)	96,000,000
Balance—deficit at Year 35	$310,200,000

This summary includes only those returns to the Project that are assured and measurable. While the estimates are subject to error, they serve to illustrate the prospective status of the Project on the basis of one possible set of assumptions. These assumptions included the most favourable submitted to the Commission regarding the value of the power development, and the most optimistic of the P.F.R.A. estimates of agricultural returns.

108. No estimate of the net gain in the revenues of government is included in this summary because such a gain is certain only if the investment in the Project did not restrict investments of equal magnitude in other projects, as it would tend to do under full employment conditions. Furthermore, in the absence of full employment, any increase in governments' revenues would be offset to some unpredictable extent by a concomitant increase in the expenditures by governments. Finally, any net increase in the revenue of governments represents a deduction in the private revenues or incomes created by the Project.

109. Certain adverse effects are omitted from the summary because of their immeasurability. Among the more important of these are the virtual losses of value that would be imposed on some agricultural lands in the region as a result of the superior competitive position of the Project, particularly with respect to prairie markets for dairy and livestock products. The adverse effect of the use of the river for irrigation upon the value of power sites below the damsite is also ignored; but this adverse effect would be partially offset by the beneficial effect of improved stream control.

110. The deficit reflects the cost to the Canadian people of the various indirect and social benefits associated with the Project. These include:

(a) additional income accruing to associated dry land producers;

(b) indirect income benefits enjoyed by producers in the irrigable area;
(c) the net additions to the national income arising with new opportunities that might be created for the employment of labour and capital outside of agriculture as a result of a more stable and higher level of farm spending in the area;
(d) the creation of opportunities within agriculture for some 1,500 families;
(e) the increase in population and its implications for closer community life in the area;
(f) the enhanced opportunities for recreation; and various other social benefits described in this Report.

The Qu'Appelle Valley

111. The development of the historic Qu'Appelle Valley as an irrigation project with an irrigable area of 24,000 acres is a prominent feature of the South Saskatchewan Project. In addition to the irrigation benefits that may be gained in the Qu'Appelle Valley, its development represents almost the entire claim made on behalf of the Project with respect to future supplies of water for municipal and industrial purposes in the cities of Regina and Moose Jaw and numerous other communities in south central and southeastern Saskatchewan. The Qu'Appelle Valley contains six large lakes. Associated with it are Last Mountain Lake and Little Manitou Lake, and Katepwa and Little Manitou Provincial Parks. Regulation of the flow of the Qu'Appelle River, with maintenance of the levels of these lakes, would safeguard and greatly enhance the amenities of the Valley region. The Commission points out that the Federal Government has already accepted a commitment to maintain the level of Buffalo Pound Lake for the purpose of urban water supply. This will involve either the installation of pumping facilities to lift water from the South Saskatchewan River, or some other development. The City of Regina is engaged on the construction of extensive works to pipe water from Buffalo Pound Lake. If the South Saskatchewan Project were built, Buffalo Pound Lake could be fed by gravity from the large reservoir. This would create a saving in pumping costs to offset, to a relatively modest degree, the cost of the larger Project. The entire range of benefits available from the regulation of the Qu'Appelle River can be achieved by due foresight in the provision of pumping or other facilities on an adequate scale. The Commission recommends that the full development of the Qu'Appelle River be undertaken immediately on the basis of an assured level in Buffalo Pound Lake.

The Delta Region

112. The desirability of extending the frontiers of agricultural production in Western Canada has been called to the Commission's attention. As an essential of public policy, the Prairie Provinces will be concerned for some years to come with programs of clearing and breaking new land. It should be noted that the logic of national development does not, in itself, serve to commend a particular undertaking such as the South Saskatchewan River Project. So rich and varied are the opportunities in

Canada, both to bring new land under cultivation and to apply intensive methods, that new sources of food production may be opened up as quickly and as cheaply as anywhere in the world. Though irrigation results in making land available for the production of food, the Commission's reference did not require it to search for alternative sources of new land. It was invited, however, to consider the problem of land reclamation in the fertile delta region of the Saskatchewan Basin. The opportunity presented to the people of Canada in this delta region is related closely to the problem of beneficial use of the resources of the river's drainage area. The delta, lying within the forks of the Saskatchewan, the Carrot and the Pasquia Rivers particularly, bestrides the Saskatchewan-Manitoba boundary. This delta contains much fertile land, created by the action of the river through countless years. It requires the protection of dykes against recurrent flooding and, in addition, some drainage works. The future development of mining and other industries in Northern Saskatchewan and Manitoba justifies an energetic effort to utilize the productive potential of the delta region. For relatively low expenditures, a large block of rich delta land can be reclaimed. The Commission recommends, therefore, that the appropriate works should be undertaken immediately to permit the settlement of 75,000 to 100,000 acres between the Saskatchewan and the Pasquia Rivers, adjacent to The Pas.

Respectfully submitted,

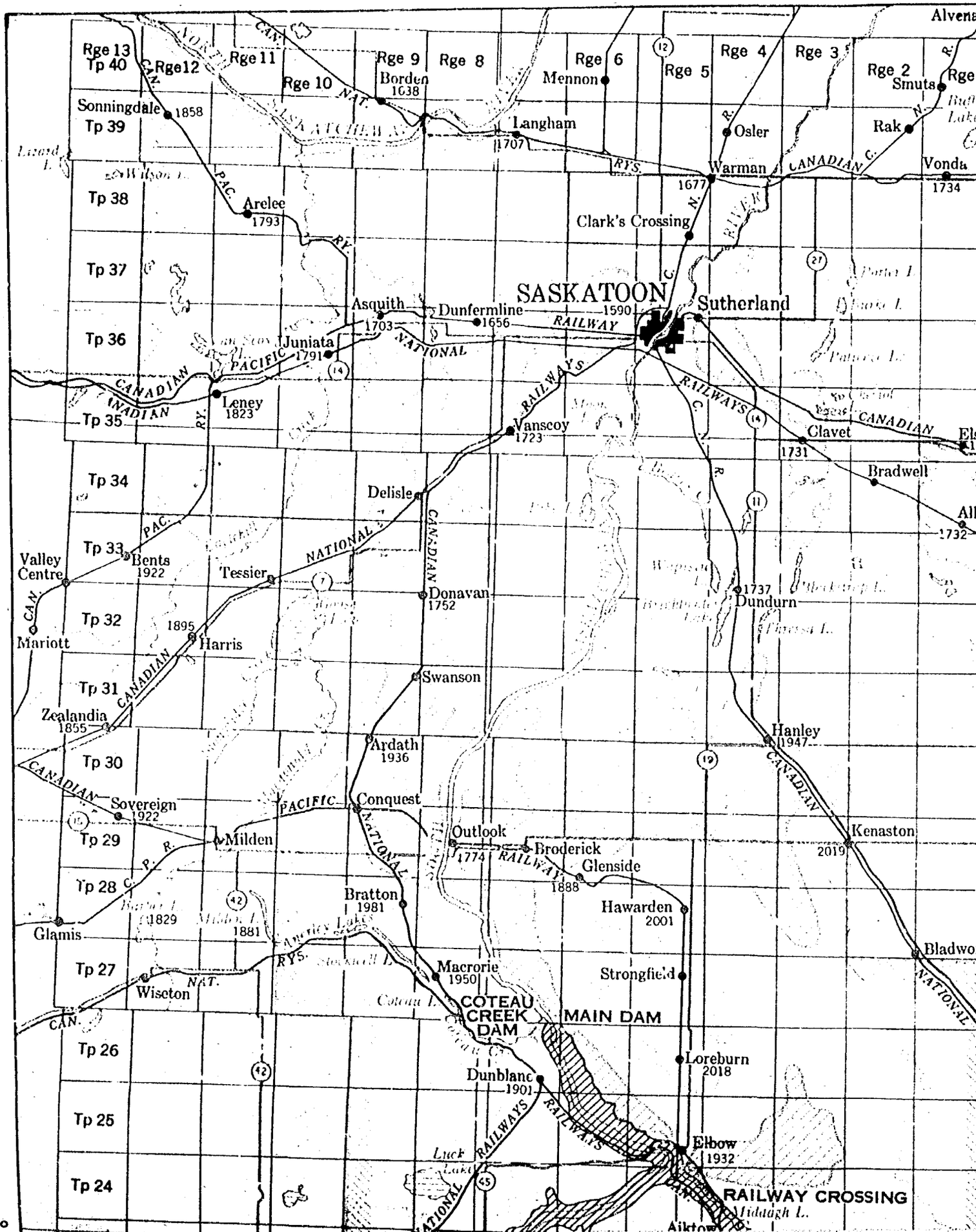
Chairman.

Commissioner

Commissioner

October 29, 1952.

NOTE: The death of Dr. John A. Widtsoe occurred in Salt Lake City on November 29, while the report was being printed.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Mennon
Langham 1707
Osler
Smuts
Rak
Warman 1677
Vonda 1734
Arelee 1793
Clark's Crossing
SASKATOON
Sutherland
Asquith 1703
Dunfermline 1656
1590
Juniata 1791
Leney 1823
Vanscoy 1723
Clavet 1731
Bradwell
Delisle
Valley Centre
Bents 1922
Tessier
Donavan 1752
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Dundurn
Mariott
1895
Harris
Swanson
Zealandia 1855
Ardath 1936
Hanley 1947
Sovereign 1922
Conquest
Milden
Outlook 1774
Broderick
Glenside 1888
Kenaston 2019
Bratton 1981
Hawarden 2001
Glamis
1829
1881
Macrorie 1950
Strongfield
Wiseton
COTEAU CREEK DAM
MAIN DAM
Loreburn 2018
Dunblanc 1901
Elbow 1932
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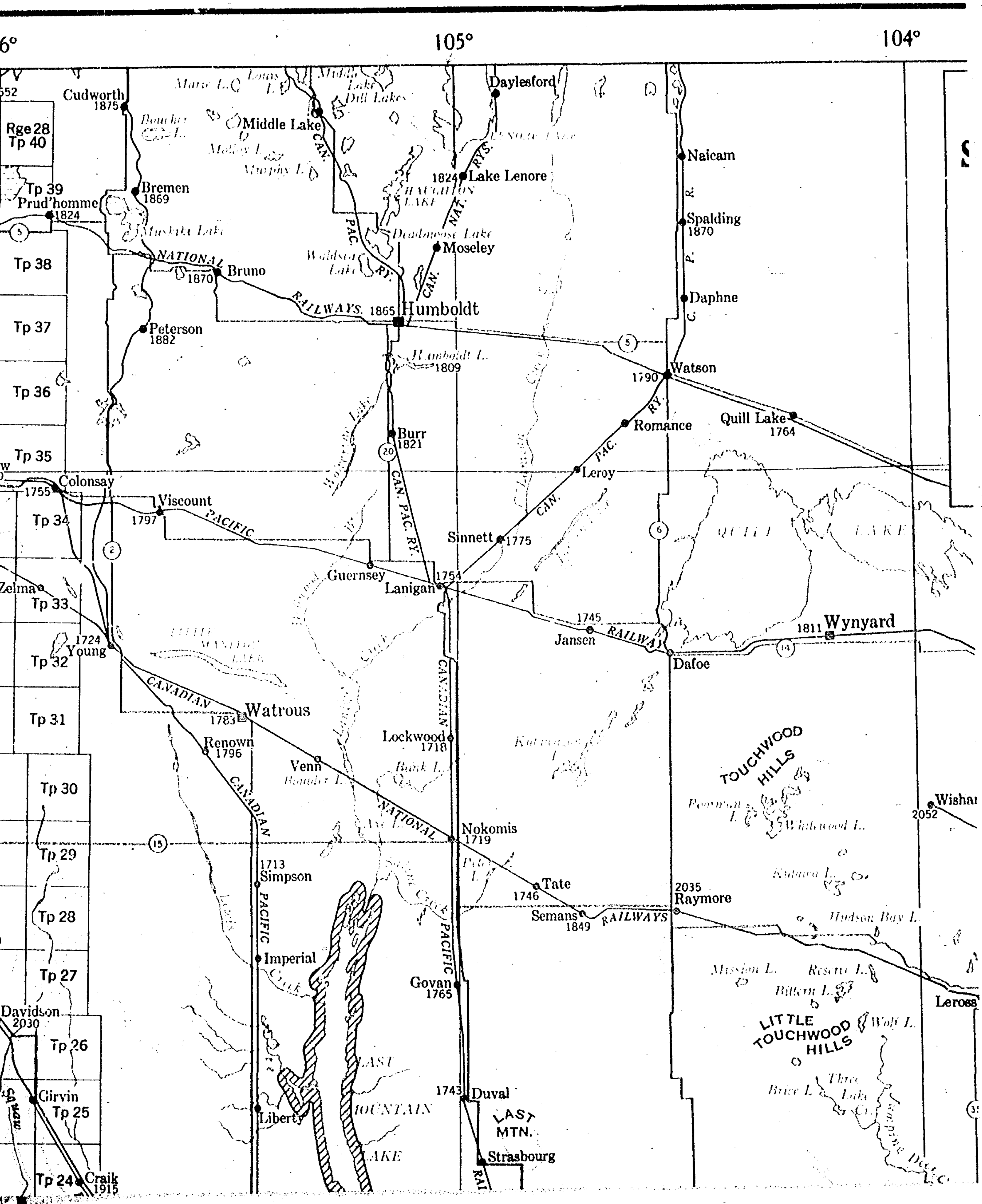
N.
RIVER
RAILWAY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Daylesford
Lake Lenore
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Naicam
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Prud'homme
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Bremen
1869
Spalding
1870
Moseley
Tp 38
Bruno
1870
NATIONAL
RAILWAYS
Humboldt
1865
Daphne
Tp 37
Peterson
1882
Watson
1790
Tp 36
Romance
Quill Lake
1764
Burr
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Tp 35
Colonsay
1755
Leroy
Viscount
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Tp 34
PACIFIC
Sinnett
1775
QUILL LAKE
Guernsey
Lanigan
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Zelma
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Jansen
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Young
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CANADIAN
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Renown
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Venn
Lockwood
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TOUCHWOOD HILLS
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Simpson
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Tate
1746
Raymore
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Semans
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RAILWAYS
Tp 28
PACIFIC
Imperial
Tp 27
Govan
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Leross
Davidson
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LITTLE TOUCHWOOD HILLS
Tp 26
Girvin
Tp 25
Duval
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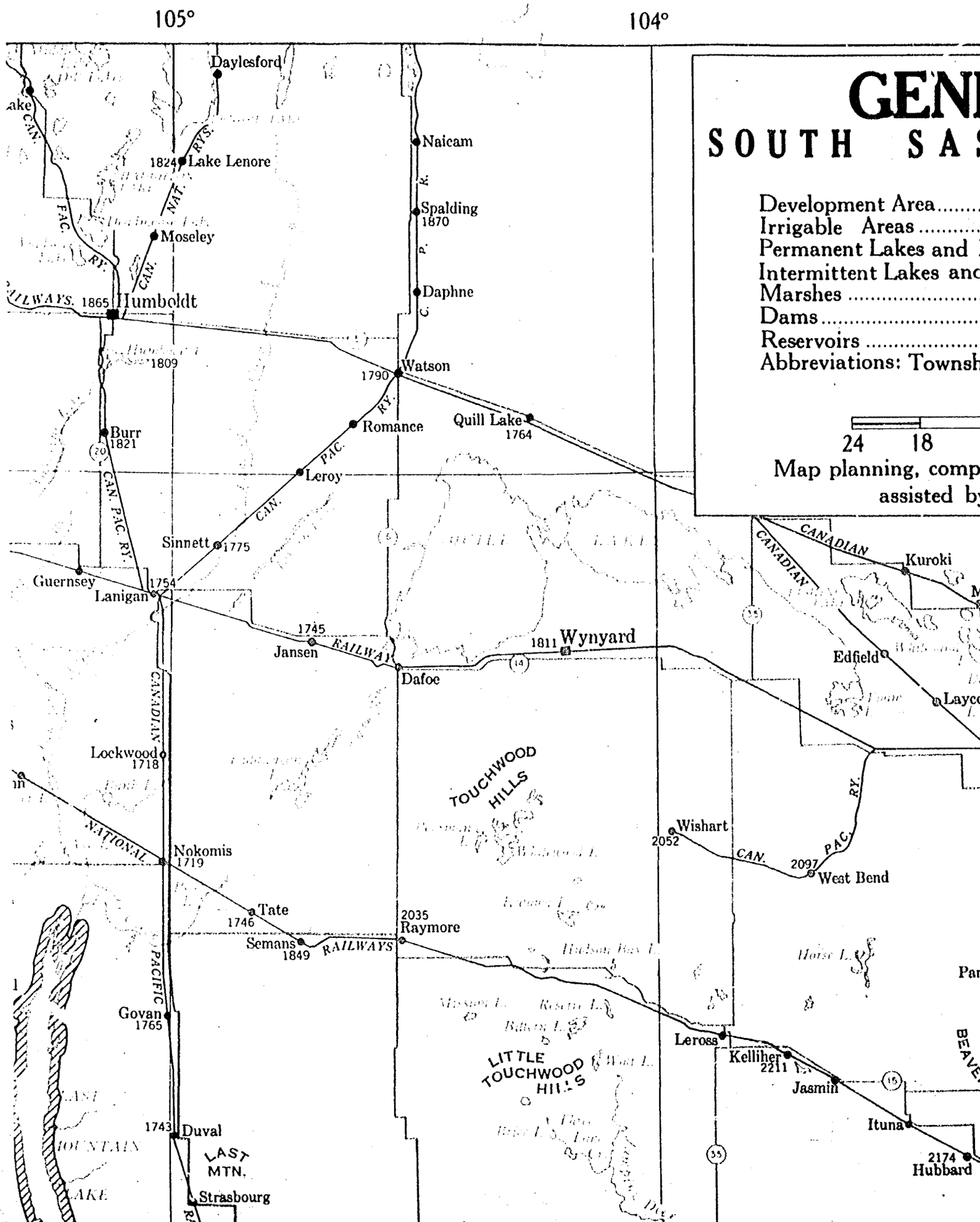
Liberty
LAST MTN.
LAST MOUNTAIN LAKE
Strasbourg
Tp 24
Craik
1915
CAN. PAC. RY.
CAN. NAT. RYS.
C. P. R.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SOUTH SA
Development Area
Irrigable Areas
Permanent Lakes and
Intermittent Lakes and
Marshes
Dams
Reservoirs
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Naicam
1824 Lake Lenore
Spalding
1870
Moseley
Daphne
1865 Humboldt
1809
Watson
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Quill Lake
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Romance
Burr
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Leroy
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Guernsey
Lanigan
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1745
Jansen
1811 Wynyard
Dafoe
Kuroki
Edfield
Lockwood
1718
TOUCHWOOD HILLS
Wishart
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West Bend
Nokomis
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Raymore
Semans
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Govan
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Leross
Kelliher
2211
Jasmin
Ituna
1743 Duval
LAST MTN.
Strasbourg
LITTLE TOUCHWOOD HILLS
2174
Hubbard
CANADIAN
NATIONAL
PACIFIC
CAN. PAC. RY.
CAN. PAC. RY.
CAN. NAT. RYS.
RAILWAYS
BEAVER

103° 102°

ERAL REFERENCE MAP

KATCHEWAN RIVER PROJECT

LEGEND

.....	Relief above 2000' .....
.....	Spot Elevations 1875
ivers.....	Roads .....
Rivers.....	Railroads ..... C. N. R.
.....	..... SASKATOON
.....	Cities and Towns ..... YORKTON
.....	..... Wynyard
.....	..... Delisle

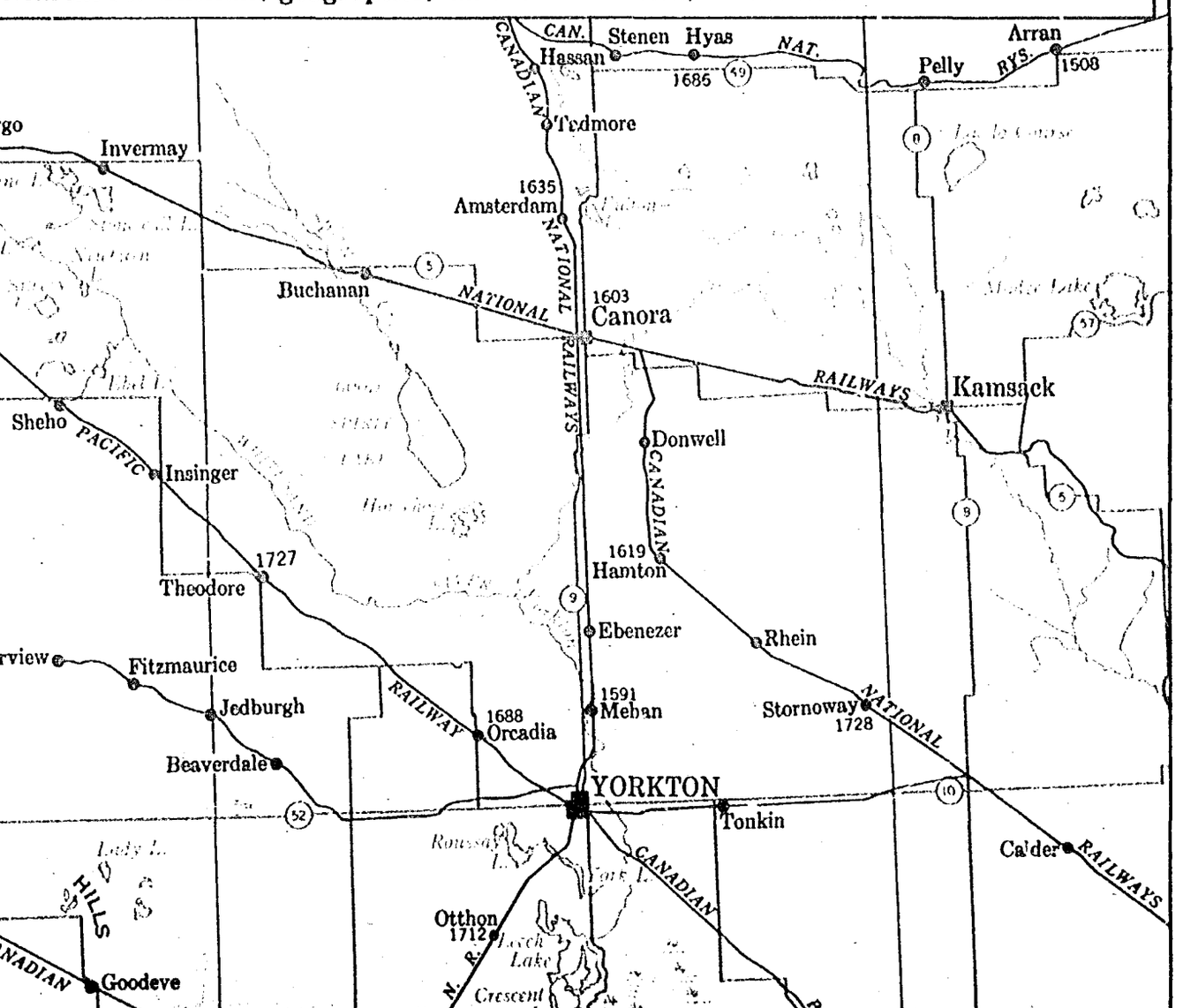
o = Tp Range = Rge

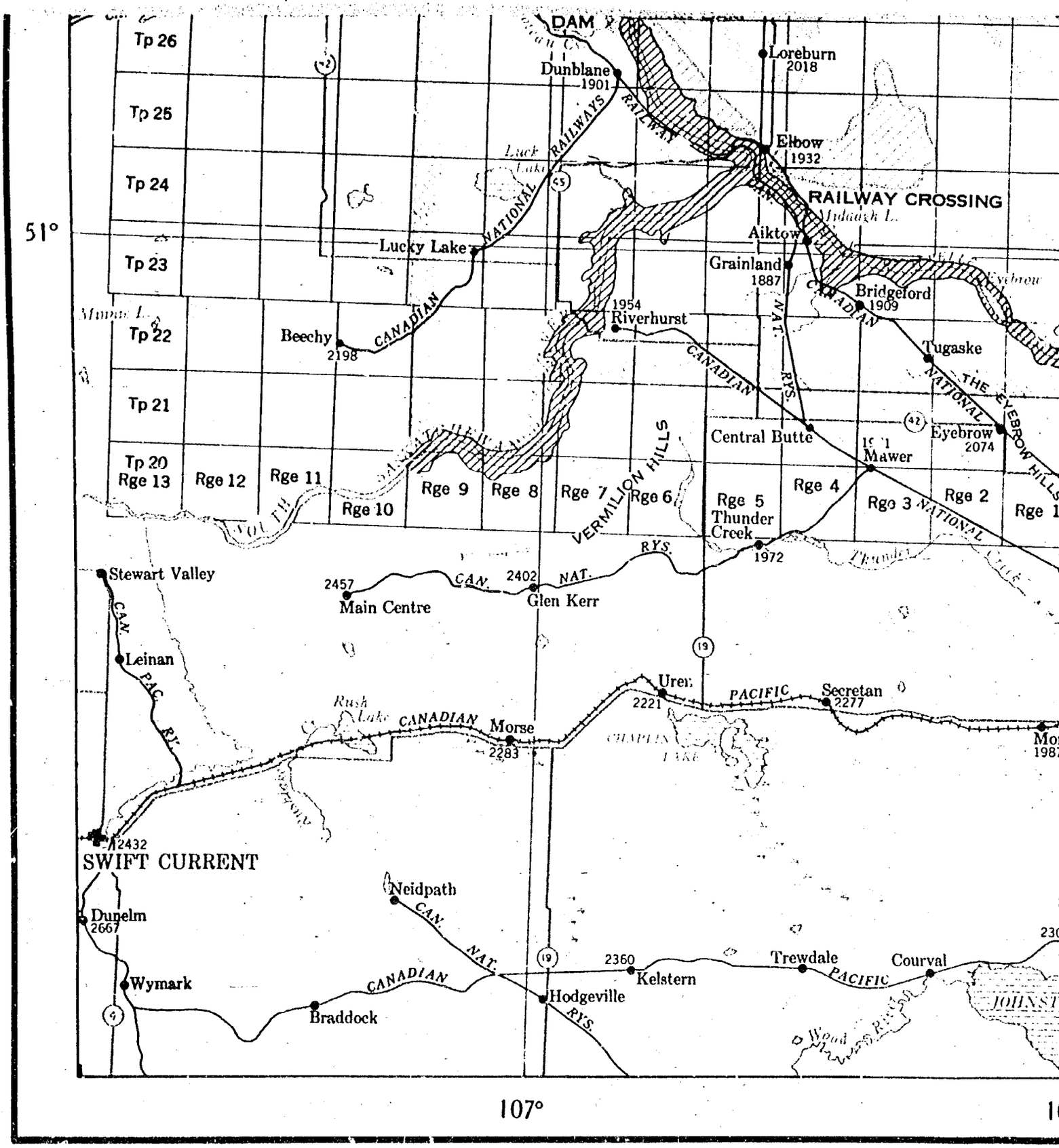
Scale in Miles

2 6 0 12 24 36 48

52°

ation, drafting and editing by Paul-H. Laurendeau, geographer- cartographer, Martin-H. Sinclair, geographer, and Gilles Morin, draftsman.




DAM
Loreburn
2018
Dunblane
1901
Elbow
1932
RAILWAY CROSSING
Aiktow
Grainland
1887
Bridgeford
1909
Lucky Lake
Beechy
2198
1954
Riverhurst
Tugaske
Central Butte
Eyebrow
2074
Mawer
Thunder Creek
1972
Stewart Valley
2457
Main Centre
2402
Glen Kerr
Leinan
Urer
2221
Secretan
2277
Morse
2283
2432
SWIFT CURRENT
Neidpath
Dunelm
2667
Wymark
Braddock
2360
Kelstern
Hodgeville
Trewdale
Courval
Rge 13
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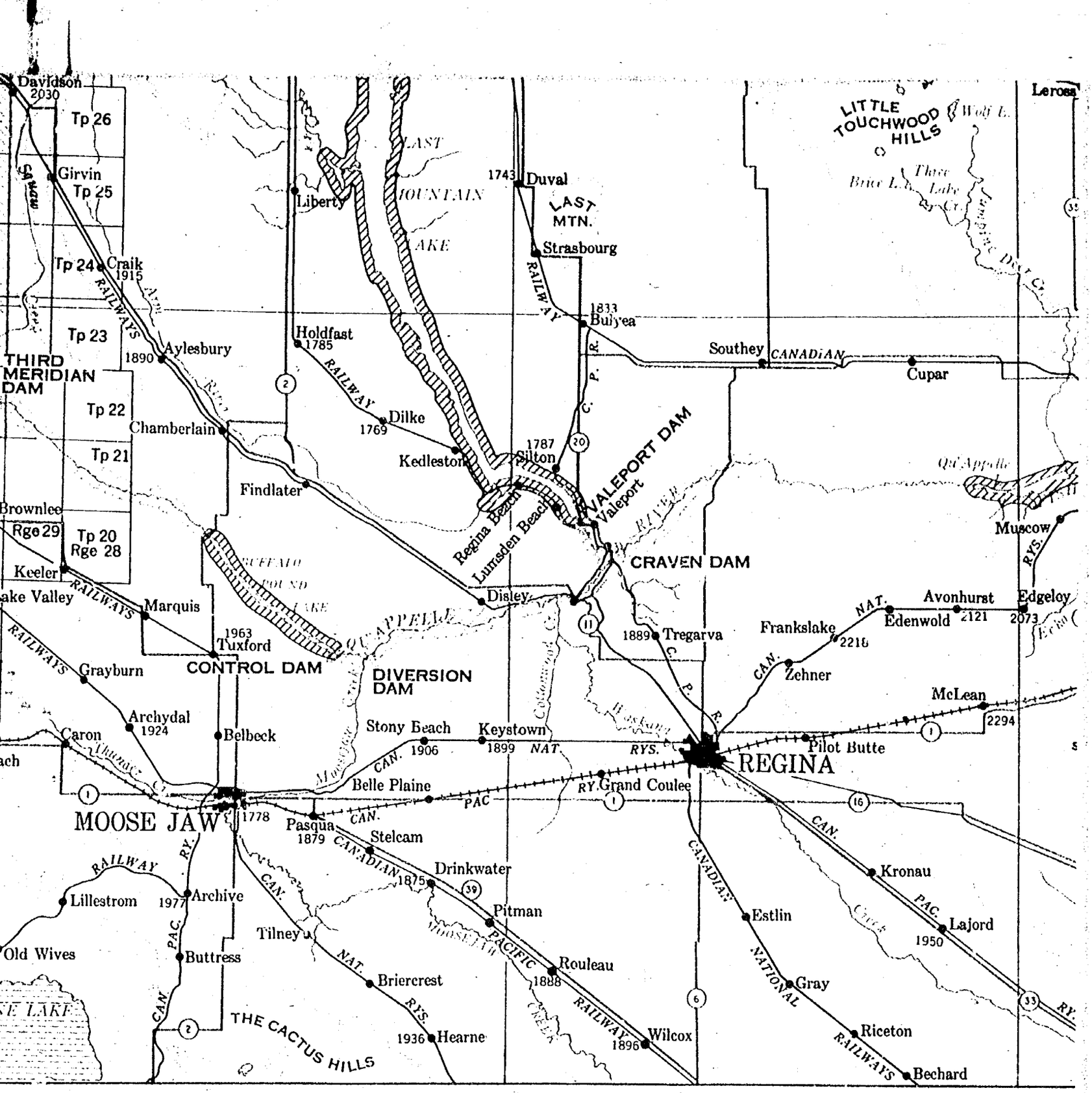
THE EYEBROW HILLS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THIRD MERIDIAN DAM
Aylesbury
1890
Tp 22
Chamberlain
Tp 21
Brownlee
Rge 29
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Keeler
Marquis
1963
Tuxford
CONTROL DAM
Grayburn
Archydal
1924
Caron
Belbeck
MOOSE JAW
1778
Lillestrom
1977
Archive
Old Wives
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THE CACTUS HILLS
1936
Hearne
Briercrest
Tilney
Pasqua
1879
Stelcam
Drinkwater
1875
Pitman
Rouleau
1888
Wilcox
1896
Bechard
Riceton
Gray
Estlin
Lajord
1950
Kronau
Belle Plaine
Grand Coulee
Stony Beach
1906
Keystown
1899
Pilot Butte
REGINA
McLean
2294
Zehner
Frankslake
2215
Tregarva
1889
Edenwold
2121
Avonhurst
Edgeley
2073
Muscow
CRAVEN DAM
Disley
Regina Beach
Lumsden Beach
Valeport
VALEPORT DAM
Silton
1787
Kedleston
Dilke
1769
Holdfast
1785
Liberty
Duval
1743
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Strasbourg
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Southey
Cupar
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LITTLE TOUCHWOOD HILLS
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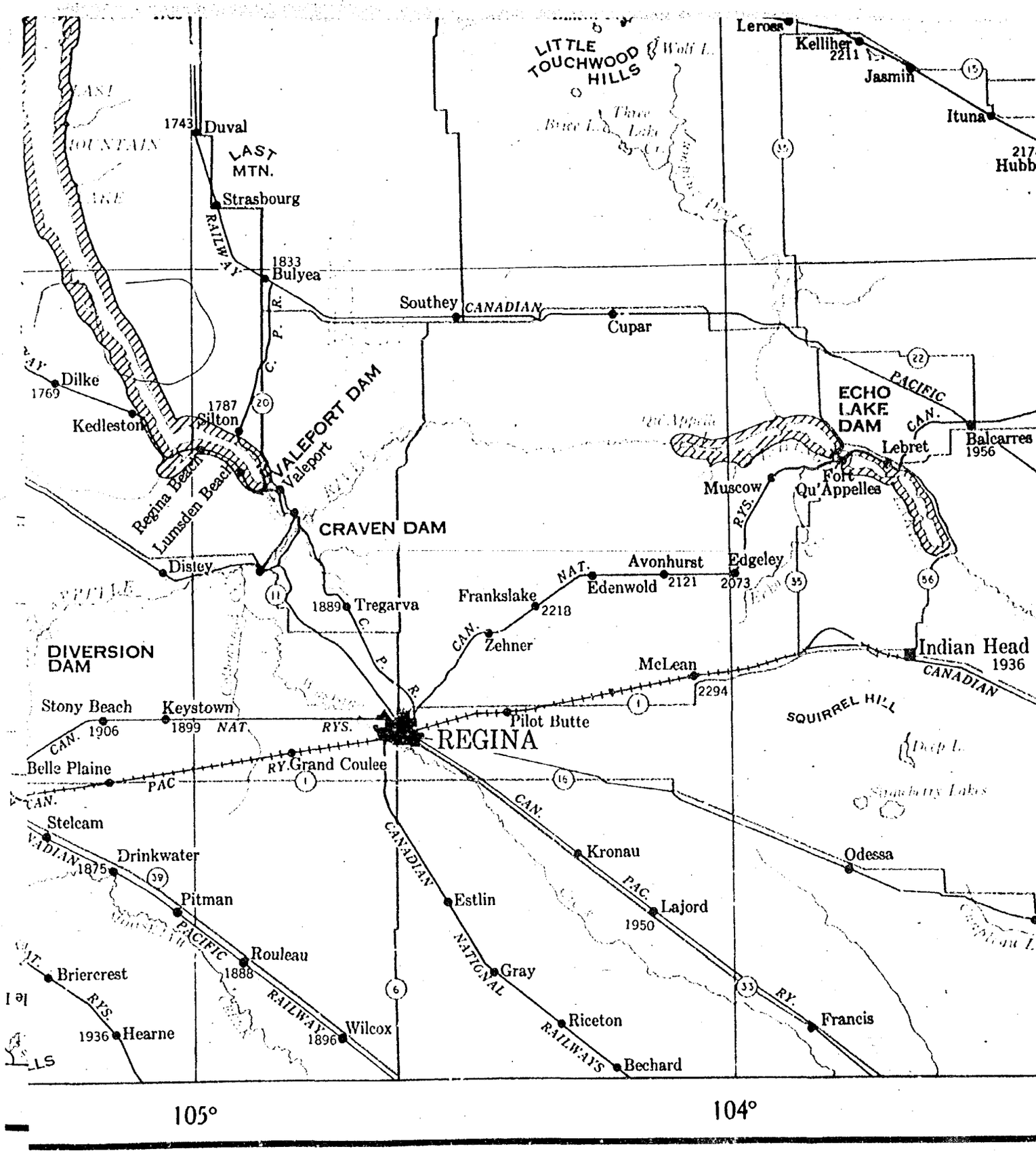
LITTLE TOUCHWOOD HILLS
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ECHO LAKE DAM
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Balcarres
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Lebret
Fort Qu'Appelles
Muscow
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Valeport
Regina Beach
Lumsden Beach
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Disley
Avonhurst
Edgeley
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McLean
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REGINA
Belle Plaine
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Grand Coulee
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Drinkwater
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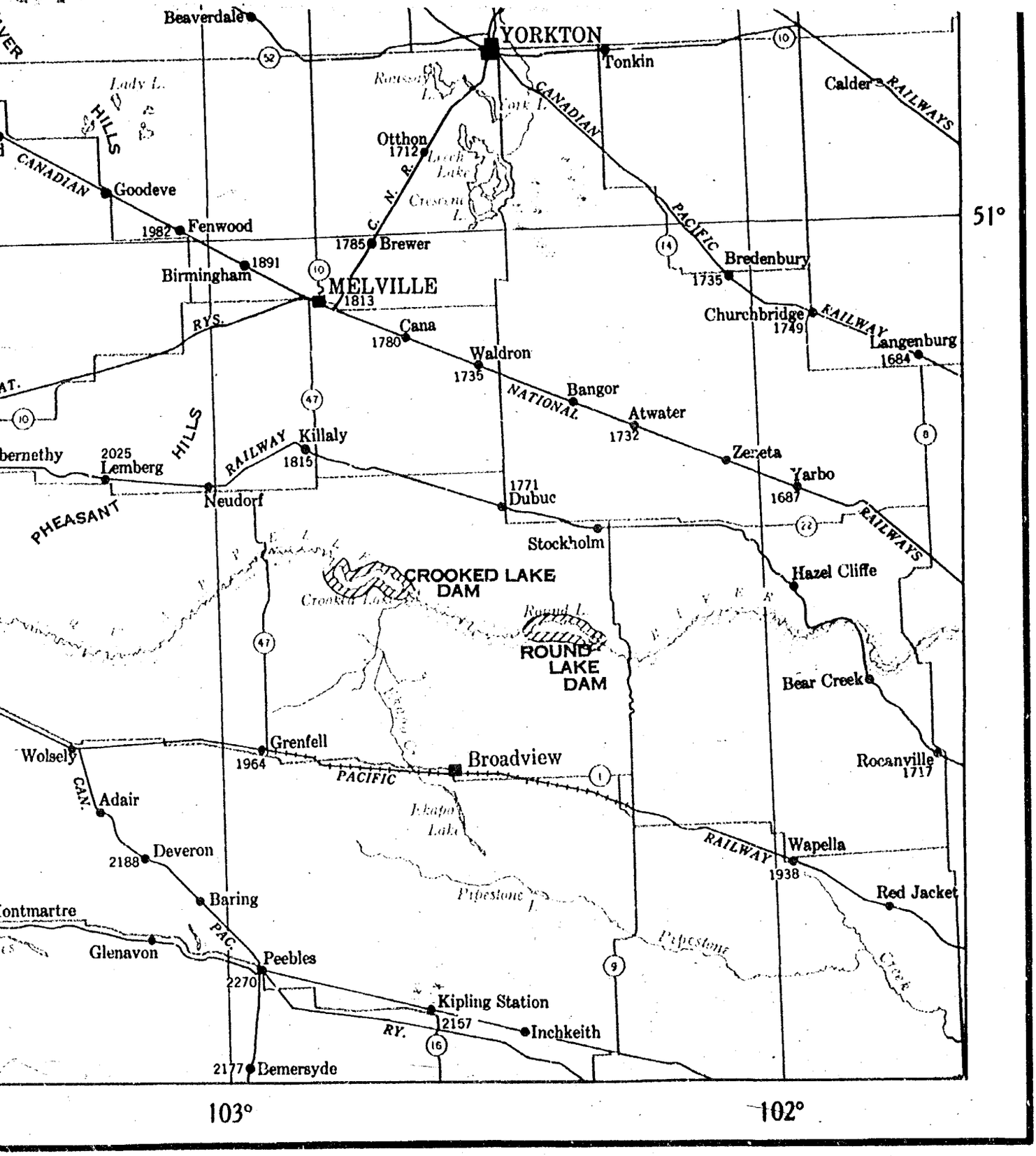
PACIFIC
Rouleau
1888
RAILWAY
Wilcox
1896
Briercrest
RYS.
1936
Hearne
CANADIAN
Estlin
Kronau
PAC.
Lajord
1950
Odessa
NATIONAL
Gray
RAILWAYS
Riceton
Bechard
RY.
Francis
105°
104°


Beaverdale
YORKTON
Tonkin
Calder
RAILWAYS
CANADIAN
Lady L.
HILLS
Otthon
1712
Crescent L.
CANADIAN
Goodeve
1982
Fenwood
1785
Brewer
PACIFIC
51°
Bredenbury
1735
1891
Birmingham
MELVILLE
1813
RYS.
Churchbridge
1749
RAILWAY
Langenburg
1684
Cana
1780
Waldron
1735
NATIONAL
Bangor
Atwater
1732
Zeneta
Yarbo
1687
Killaly
1815
HILLS
RAILWAY
2025
Lemberg
PHEASANT
Neudorf
1771
Dubuc
Stockholm
RAILWAYS
CROOKED LAKE DAM
Hazel Cliffe
ROUND LAKE DAM
Bear Creek
Grenfell
1964
Broadview
Wolsely
PACIFIC
Rocanville
1717
Adair
Deveron
2188
Wapella
1938
RAILWAY
Baring
Red Jacket
Glenavon
Peebles
2270
Kipling Station
2157
Inchkeith
RY.
2177
Bemersyde
103°
102°

PART II

The River Basin and Its Development

CHAPTER 1

Introduction and Acknowledgments

THE members of the Commission have been profoundly impressed by the magnitude of the proposed South Saskatchewan River Project and its estimated cost. The Project would transform, in part, the region in which it would be situated. As an enterprise in resource development, the concept of employing the physical resources of the Saskatchewan River Basin in "the most profitable and desirable" way has few parallels in Canadian experience. At a time when the conservation of water has become a pressing problem in many regions of North America, an inquiry such as the Commission was requested to carry out involves matters of interest and significance to the Canadian people.

The Commission's inquiry appeared at first to fall into two distinct parts, namely, whether the economic and social returns would be commensurate with the cost of the Project, and whether it represents the most profitable and desirable use which can be made of the physical resources involved. Many important and varied factors involved in the inquiry, however, are pertinent to both questions.

The Commission's inquiry was organized at a first meeting in Ottawa, a few days after the Commission was established by Order in Council P.C. 4435, August 24, 1951. The Commission received voluminous reports from the administration of the Prairie Farm Rehabilitation Act on many phases of the Project. The task of reviewing the material supplied by the P.F.R.A., without which the inquiry could scarcely have been undertaken, occupied much more time than had been expected.

The scale of these reports may be judged from the following list:

1. Report on Recreational Benefits. Progress Report. By J. A. Boan, prepared for P.F.R.A.
2. The Development of Irrigation in Alberta. An Historical Survey. By C. S. Burchill, Dominion Economics Division, University of Alberta, Edmonton, Alta.
3. Power Report. Central Saskatchewan Development. By David Cass-Beggs, P.Eng.
4. The Climate of the South Saskatchewan Irrigation Project. By B. W. Currie, Ph.D., University of Saskatchewan, Saskatoon, Sask.
5. Engineering Features of the South Saskatchewan Irrigation Project. By G. L. MacKenzie, Chief Engineer, P.F.R.A., Regina, Sask.
6. Soil Survey Report of the South Saskatchewan Irrigation Project (revised—1949). By H. C. Moss, W. K. Janzen and J. E. McClelland, University of Saskatchewan, Saskatoon, Sask.
7. Land and Development Policy for Newly Created Irrigation Districts with Special Reference to South Saskatchewan Development Area. By C. C. Spence, Dominion Economics Division, University of Alberta, Edmonton, Alta.
8. Study of the Irrigation Phase of the Proposed South Saskatchewan River Development Project. By H. Van Vliet, Gordon Haase and R. A. Stutt.

Meanwhile, the Commission undertook to notify, through the medium of personal calls by one or more members and the Secretary, the Governments of Manitoba, Saskatchewan and Alberta of the purposes of the inquiry and to invite them to submit views relative to the terms of reference. Subsequently the Provinces of Saskatchewan and Alberta filed comprehensive submissions, the former expressing its views initially in an Interim Statement which was followed, four months later, by a longer submission. Several meetings were held with Ministers or officials of the Manitoba Government, with the result that the views of Manitoba were obtained. A letter was received from Premier Campbell, setting out the considered view of his Government on the matters under inquiry.

These statements are found in the Appendix to this Report. The Commission desires to express its thanks to the Provincial Governments which, being concerned with the development of the Saskatchewan River Basin, assisted materially in the inquiry.

In addition the Commission requested reports from qualified persons on specific subjects. These form Part II of the Report. The Commission unfortunately found that a large amount of written reports could not be included in this Report in convenient and readable form. Such data and conclusions as are necessary to the Report will be found in references to and quotations from this material. The studies undertaken for the Commission include the following:

1. Full Development Possibilities in Saskatchewan River Basin. By W. M. Berry, Chief Hydrologist, Department of Agriculture, Regina, Sask.
2. Short-Run Effects of the South Saskatchewan River Development. The Question of its Real Cost. By K. A. H. Buckley, Ph.D., Department of Economics, University of Saskatchewan, Saskatoon, Sask. *Also* Long Run Economic and Social Benefits of South Saskatchewan River Project, same author.
3. The Economic Development of the Prairie Provinces with Particular Reference to the South Saskatchewan River Basin. By Vernon C. Fowke, Department of Economics, University of Saskatchewan, Saskatoon, Sask.
4. The Economic Basis for Past Irrigation Expenditure in Alberta. By Hu Harries, Edmonton, Alta.
5. Memorandum Relating to an Enlargement of the Proposed Reservoir at Outlook, Saskatchewan, and to the Red Deer Project. By D. W. Hays, Medicine Hat, Alta. Memorandum Respecting Irrigation Requirements and Water Supply. By D. W. Hays, Medicine Hat, Alta.
6. The Geographical Setting. Saskatchewan River Drainage Basin. By the Geographical Branch, Mines and Technical Surveys Department, Ottawa.

The Commission deemed it advisable to arrange a conference with the senior engineering consultants of the P.F.R.A. on the Project, and this was done. The conference, held in Washington, D.C. in April, 1952, was attended by a number of officials and advisers of the P.F.R.A. and, as well, an observer from the Saskatchewan Government. This conference served to clarify many engineering aspects of the Project, and confirmed the Commission in a decision to obtain an independent estimate of the overall cost. Those attending the conference in Washington were:

Dr. T. H. Hogg, Chairman
G. A. Gilbert, Commissioner
B. T. Richardson, Secretary
Gordon Haase, Commission Economist
D. W. Hays, Commission Consultant
Miss M. A. Mosley, Asst. Secretary
Major General H. B. Ferguson, Cons. Engineer, Washington, D.C.
Dr. A. Casagrande, Harvard University, Cambridge, Mass.

L. F. Harza, Harza Engineering Co., Chicago.
G. L. MacKenzie, Chief Engineer, Prairie Farm Rehabilitation
G. Parkinson, P.F.R.A.
R. O. Peterson, P.F.R.A.
J. G. Watson, P.F.R.A.
Dr. J. D. Mollard, P.F.R.A.
W. T. Pyott, Chief Engineer, Mannix Ltd.
O. M. Strange, Engineer, Morrison-Knudsen Co. Inc.
O'Dean Anderson, Engineer, Morrison-Knudsen Co. Inc.
J. W. Tomlinson, Gen. Mgr., Saskatchewan Power Corp., Regina.
W. B. Ramsay, President, Beattie Ramsay Construction Co. Ltd.
D. S. MacDonald, Gen. Mgr., Bird Construction Co. Ltd.

For the preparation of an estimate of cost, which will be found in Part II of the Report, the Commission retained Mannix Ltd., Calgary, Alta. The Commission desires to express its thanks to Mr. Fred Mannix, Jr., Mr. Wm. T. Pyott and Mr. R. Walford of that Firm for their assistance. The preparation of the cost estimate by Mannix Ltd. was undertaken and completed, at the request of the Commission, in a far shorter period of time than would normally be required for work of this kind.

As will be seen from the letter accompanying the estimate furnished by Mannix Ltd., a number of United States firms assisted with advice based upon experience directly related to large-scale construction projects similar to that under inquiry by the Commission. The Commission desires to thank the individual members of these firms who assisted in preparing the estimate.

The Commission desires to express its thanks to the United States Bureau of Reclamation and its Commissioner, Mr. Michael Straus, for much valuable material and for the courtesy of a conference with Mr. Straus and several of his key advisers at the Bureau's offices in Washington, D.C., in April, 1952.

To many staff members of the P.F.R.A. the Commission's inquiry has meant extra work during the past year. The Commission desires to thank all of them for their courteous co-operation and to single out particularly Dr. L. B. Thomson, the Director, Mr. Gordon L. MacKenzie, the Chief Engineer, and of their staff, Mr. George Munro, Mr. Gordon Watson and Mr. Wm. M. Berry. In reviewing material, in discussing the inquiry and in inspecting the Project site, the assistance of the P.F.R.A. organization has been invaluable to the Commission.

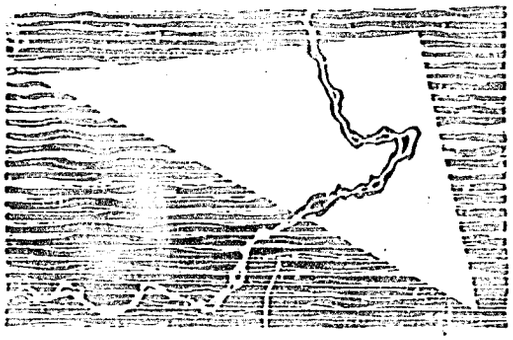
The Commission held public hearings at Lethbridge, Alberta, on May 2, 1952, obtaining a valuable insight into the progress and problems of the established irrigation projects in Alberta. Those who came forward and testified included Dr. W. H. Fairfield, Messrs. Phil Baker, P. M. Sauder, C. Clendening, A. E. Palmer, W. L. Jacobson, and Wm. M. Berry. The Commission desires to thank these experienced irrigators for their assistance to the inquiry.

Public hearings were held at Outlook, Sask., on Sept. 9, at Regina, Sept. 10 and 11, and Saskatoon, on Sept. 12. A list of those who appeared will be found in the Appendix to this Report, along with the text of numerous submissions. The Commission has sought to weigh carefully all the data received and wishes to express its thanks to all those who came forward to present their views.

A number of Departments of the Federal Government have supplied valuable assistance to the Commission, both in loaning personnel and furnishing information from time to time. Wherever possible, credit for such assistance has been given at the appropriate place in the Report. Two members of the Department of Agriculture who have rendered exceptional service to the Commission in its inquiry and in the preparation of its Report have been Mr. Gordon Haase and Dr. Kenneth W. Hill.

In the preparation of the Report, a brief account of the geographical setting of the South Saskatchewan River Development was furnished by the Geographical Branch, Department of Mines and Technical Surveys, under its director, Dr. J. Wreford Watson. The assistance of this Branch in the preparation of maps included in the Report was invaluable. Much of the work of preparing the maps was done by staff members of the Branch, in addition to their regular duties. The Commission desires to express its thanks to the Deputy Minister of Mines and Technical Surveys, Mr. Marc Boyer, to Dr. Watson, and to the chief cartographer of the Branch, Mr. Paul Laurendeau, who directed the technical work of producing the maps.

Finally, the assistance given to the Commission by Mr. David W. Hays of Medicine Hat, Alberta, has been of particular value in view of Mr. Hays' long experience in practical irrigation in Alberta and his wide knowledge of all aspects of the subject.



CHAPTER 2

The Geographical Setting

In a country of great river systems, the Saskatchewan River ranks as the fourth longest in Canada. The Mackenzie is the longest, followed by the St. Lawrence and the Yukon. Since the Mackenzie and the Yukon lie north of the more densely settled areas, the Saskatchewan is the second longest river in the settled part of the country.

From its source in the eastern ranges of the Rockies, the river flows across the three Provinces of Alberta, Saskatchewan and Manitoba, and empties into the north end of Lake Winnipeg. Here the Saskatchewan proper ends, but its waters travel another 400 miles as the Nelson River before reaching salt water at Hudson Bay. Altogether the watershed of the Saskatchewan River covers about 148,000 square miles or 95½ million acres. In its immense extent, the basin runs through 18 degrees of longitude, from 117 degrees west to 99 degrees west and through 5 degrees of latitude from 49 degrees north to 54 degrees north. This great longitudinal and latitudinal extent gives rise to greatly diverse geographical conditions within the watershed as a whole.

The Saskatchewan River is made up of two main branches referred to as the North Saskatchewan and the South Saskatchewan or the North Branch and the South Branch. Each of these has numerous tributaries. Two of the larger tributaries of the North Branch are the Brazeau and the Clearwater; the South Branch has a number of large tributaries, in particular the Oldman, the Bow and the Red Deer.

The Columbia Ice Field, the largest glacier left in Canada, gives rise to both branches within half a mile of each other. Some of the southern tributaries rise in Glacier National Park in Montana. The two main branches, despite a common origin, diverge until they are 300 miles apart. Then they begin to converge until, 800 miles later, they sweep together at the Forks, east of Prince Albert in Central Saskatchewan. The main stem runs thence another 340 miles before emptying into Lake Winnipeg.

The watershed of the North Branch is 82,500 square miles in extent, covering 52,800,000 acres. The watershed of the South Branch is somewhat smaller, with an area of 65,500 square miles covering 41,920,000 acres. The North Branch occupies 56 percent of the whole drainage system, and the South Branch 44 percent. The watershed of the Saskatchewan River system and that of the Nelson drain almost all of the Canadian prairies below the 54th parallel.

This chapter was prepared by M. R. Dobson, Geographical Branch, Department of Mines and Technical Surveys.

To the north are the Mackenzie-Athabasca-Peace systems. To the southeast is the Qu'Appelle-Red River system and to the south the Missouri system. The western side of the basin is bounded by the eastern ranges of the Rocky Mountains, with the Columbia River system just over the divide.

Relief

In the main the watershed is underlain by nearly horizontal strata of Tertiary and Cretaceous rocks, and towards its mouth by Silurian and Ordovician formations. These have been little affected by the faulting and folding which are so evident in the western part of the basin.

The elevations across which the watershed lies reflect very strongly the horizontal nature of the underlying strata. The whole of the plain of Western Canada slopes eastward and to the north. Three distinct levels of elevation are clearly marked, and are referred to as the three prairie steppes. The highest slopes eastward and northward from an altitude of 4,000 feet at the foothills, to 2,200 feet at its eastern limit marked by the Missouri Coteau. The Coteau or escarpment appears as dirt hills rising 300 feet to 500 feet above the surrounding prairie. It cuts across the watershed somewhat west of a line drawn through Weyburn and Moose Jaw. Erosion on this prairie level has proceeded further than on the other two prairie steppes. It has been worn down, in some areas, into rounded knob-like hills. Near the river, deep drains and coulees give rise to badland topography. This prairie level has much more broken relief than have the next two levels.

Relief within the watershed on the intermediate prairie level is that of a rolling plateau with an average altitude of about 1,600 feet. The surface is scored by the deeply trenched river and is marked by frequent level lake-bottoms. The eastern limit of this level is marked by the Manitoba Escarpment. This feature rising to 2,000 feet appears as a line of hills, isolated from each other by many eastward flowing rivers. East of this and stretching across the Red River valley to the Canadian Shield is the lowest prairie level with an average elevation of about 800 feet. This flat, featureless plain corresponds closely to the bed of glacial Lake Agassiz.

The North Saskatchewan and the South Saskatchewan unite at the Forks, on the intermediate prairie level. From this point onward, the watershed narrows rapidly, and where it crosses the lowest prairie level it has an average width of only 60 miles. From the base of the Rockies to Lake Winnipeg the fall is more than five feet to the mile. The river is normally rapid in flow, except in numerous areas where drainage is poor or where only internal drainage exists.

Climate

The Saskatchewan basin lies in the Cool Temperate zone. The annual average temperature is about 36°F, varying from 31°F at The Pas to 42°F at Medicine Hat. The mean July temperatures indicate that the summers are as warm as 65°F, with some variation depending upon the specific locality. In winter, the mean January temperatures fall to two or three degrees below zero at Saskatoon, Prince Albert and The Pas, but are as high as 12-13 degrees above zero at such places as Calgary and Medicine Hat.

However, rainfall is probably a more important factor than temperature. The watershed area varies from semi-arid in the south and southwest to sub-humid in the north and northeast. Average annual precipitation varies from about 11 inches in the south to 20 inches in the north. It is highly characteristic of the watershed area that a high proportion of the annual rainfall comes in the growing season.

Climate has a direct bearing on vegetation and the character of the soils of a region. Soils are the product of the original material composing the surface of the region, modified by climate and vegetation. This correlation is borne out by a study of the vegetation and soil belts in the Canadian prairies.

Vegetation

In general, the southern part of the basin is marked by the short grass cover. This is the northward extension of the Great Plains region of the United States. This cover merges gradually toward the north into the grove or park belt, with its tall grass vegetational cover and patches of woodlands. Still further north, but well within the watershed, are the northwestern coniferous forests of spruce and poplar, tamarack, balsam and aspen. Southern extensions of this vegetation occur in the east and in the extreme west of the basin.

Soils

The soil belts cross the watershed at approximately right angles to the north-south relief features. In general these arcuate soil belts range from the brown prairie soils in the south to the black prairie soils in the north part of the watershed, with the dark brown prairie soils in between. The transitional soils mark the gradual change from the black prairie soils to the grey podsol soils of the timber areas to the north. These are prominent along the north edge of the watershed and in the higher parts of the foothills and mountains in the west.

Thus the watershed area of the Saskatchewan River system contains within its boundaries, all the diversities in structure, climate, topography, drainage, natural vegetation and soils to be found in the whole Canadian prairies. Conditions and types of structure, drainage and topography are strongly marked from west to east while the changes in climate, natural vegetation and soils have their greatest variations from south to north. These changes of physical conditions become more apparent when one studies the watershed of the South Saskatchewan in detail.

South Saskatchewan Basin

The watershed[1] of the South Saskatchewan River, covering a drainage area of approximately 65,500 square miles, lies in the southern part of the provinces of Alberta and Saskatchewan. It is bounded on the north by the large drainage systems of its North Branch, on the east by the Qu'Appelle-Red and on the south by the Missouri in the U.S.A. To the west the boundary follows the Great Divide of the Rocky Mountains.

The greater part of the drainage area of the South Saskatchewan River system lies

[1] The term watershed is used here to describe the river and its tributaries, and is interchangeable with the terms drainage area, basin, and drainage basin.

in the southern part of the Province of Alberta. The basin narrows rapidly in its course through southwestern and south central Saskatchewan to the junction with the North Branch at the Forks.

In terms of geographical extent the basin measures approximately 480 miles, from longitude 116°W. to longitude 105°W., and 300 miles at its widest extent, from below the 49th parallel, to 53°N. latitude.

The main stream of the South Saskatchewan River actually starts where its tributary, the Oldman, having gathered up the St. Mary, The Belly and the Waterton, joins the Bow, in southeastern Alberta between the cities of Lethbridge and Medicine Hat. The tributary streams, St. Mary, the Belly and the Waterton, take their rise in the mountains of Glacier National Park, below the border between Canada and the United States of America, the 49th parallel. The tributary streams, the Oldman, the Highwood, the Little Bow, and the Bow start on the eastern slopes of the Great Divide in southern Alberta. The South Saskatchewan has one other important tributary, the Red Deer. This river, rising in the mountains close to Bow Pass, unites with the main stream at the Alberta-Saskatchewan border. Here all the tributary streams, having spread out across the foot-hills and the prairies, unite again in the main stream of the South Saskatchewan.

The South Saskatchewan River system flows generally eastward, with many meanderings and turnings and in long curving reaches of five or six miles from one side of its valley floor to the other. At the town of Elbow in Saskatchewan, the main stream turns sharply north and northeast and continues in this direction to its junction with the North Branch of the Saskatchewan River, some 60 miles east of Prince Albert.

Among the important cities within the watershed are Calgary, Lethbridge, Medicine Hat, Saskatoon and Swift Current.

Bed Rock Geology

The underlying geological structures are fairly simple. From a north-south line drawn through Cardston-Gleichen-Stettler, eastward, the whole drainage basin rests on a level Cretaceous platform with average elevation of 2,500′ above sea level. This formation, occupying 78 per cent or 50,976 square miles of the basin and lying in relatively horizontal strata, is mainly sedimentary rocks. The underlying strata have not been much affected by folding and faulting until the Rocky Mountains are approached.

The higher lands in the western part of the watershed but east of the mountains, are formed by Tertiary beds. A broad band, 60 miles wide, runs north and south across the watershed from Cardston-Gleichen-Stettler watershed to a line running north and south through Pincher Creek to Turner Valley. These formations with an average elevation of 3,500′ above sea level are Tertiary conglomerates, sandstones and shales, and occupy 15 per cent or 10.000 square miles of the basin.

The third main geological formation, running along the extreme west side of the watershed, consists of the sedimentaries of the Devonian and Carboniferous formations. Interspersed among these are extensive outcrops of Lower Cretaceous sedimentaries. These latter formations coincide with the

elevations of over 5,000′ above sea level. The Devonian and Carboniferous formations and outcrops of Lower Carboniferous underlie seven per cent or 4,500 square miles of the watershed.

The bedrock geology of the watershed is significant for three main reasons. The first is the economic importance of oil, coal, and natural gas. The second is the influence of the bedrock on the nature of the soils of the region and the third is the effect of the rock structure on the surface relief. This report will comment only on the last relationship. One of the most important effects of the underlying rock structure is revealed in part at least on the surface.

Relief

Physiographically, the western plains region, together with the foot-hills of the Rockies, are regarded as being the Interior Plains province. This broad physiographic division has a number of sub-provinces such as the Manitoba Lowlands on the east, the Cretaceous Plateau in the interior, the foothills on the west, and the Mackenzie Lowlands in the north. The South Saskatchewan basin lies across two of these sub-provinces, the foothills and the Cretaceous Plateau, with elevations as described above.

The absence of extensive folding and faulting accounts for the great areas of comparatively level lands, characteristic of the plains section within the basin.

The average elevation of the South Saskatchewan River basin varies considerably from the west to east and from north to south. In the extreme west the heights of the Rockies rise to over 5,000 feet and occupy six per cent of the basin, or 3,700 square miles. Then, the relief drops quickly to the 4,000-foot level of the foothills. The foothills of the Rockies, with an average elevation of 4,000 feet above sea level, occupy 21 per cent or 13,800 square miles of the watershed area. The highest of the three prairie levels is from 3,000 down to 2,000 feet. It occupies the bulk of the basin, covering 61 per cent or 40,000 square miles. The watershed from the point where the river debouches through the Missouri Coteau lies in the intermediate prairie steppe. It continues to its junction with the North Branch, through an elevation from 2,000 to 1,500 feet. Contained in the watershed are 7,200 square miles of this relief level, comprising only 11 per cent of the total watershed area.

During glacial times, ice advanced across what is now the three prairie provinces from the direction of Hudson Bay and from the Rockies in the west. The record of this glaciation is evidenced in a series of ridges and moraines, together with englacial lakes all pointing south-east. All the lakes are long and narrow and all the streams including long stretches of the Saskatchewan run in that direction. In the north part of the basin most of the relief is due to glacial moraines forming morainic hills which rise 300 feet above the general level of the country. The development of the relief in the whole area appears to be pre-glacial since glacial action has modified rather than determined the land forms. The region was one of deposition during the glacial era rather than one of erosion. The relief features of the plains in a broad sense may thus be said to terminate with the ice age.

In general, the surface area of the Cretaceous Plateau is broken by low hills and ridges as well as trench-like valleys. Where

the plateau merges into the foothills west of the Cardston-Gleichen-Stettler line, the irregular topography becomes even more varied. Flat hills, remnants of the plateau further east, give way to irregular and rounded knobs, the result of erosional agencies playing on the twisted and broken strata. The topography outside the actual course of the river is marked by deep ravines cut in great thicknesses of gravel and other debris washed down during geological times, from the peaks to the west.

The Missouri Coteau is one of the more striking topographical features in the watershed. This steep eastward facing escarpment cuts diagonally across the watershed at the narrow neck at Elbow, Saskatchewan. This escarpment marks the eastern edge of the highest prairie level and has an average altitude of 2,500 feet above sea level. The line of hills which distinguish it are from 300 feet to 500 feet above the general prairie level. In contrast to the scarp's steep eastward facing slope is the gentler slope to the west.

An important feature on the southwest side of the Coteau is the old drainage channels occupied by long, narrow, shallow lakes. The lakes are remnants of much larger, late Pleistocene lakes, and lie in valleys that were formed by the run-off of glacial waters or lie in depressions in the morainal areas. Most of them are undrained and alkaline. Some are very shallow and disappear in very dry seasons, leaving a white alkali flat. The most striking of these lakes lie just to the east of the basin in the area of Moose Jaw-Watrous, but many are evident in the Maple Creek-Swift Current region on the southern edge of the basin

The present drainage channels of the South Saskatchewan River system were developed by stages as the ice sheet retreated to the north and east. In terms of geological time, the river valleys are of a youthful character; that is to say, they have rather deep valleys with steep banks, and irregular gradients with periodic rapids or turbulent currents. Nowhere along its present course is there evidence of an original post-glacial valley. The new streams, which began to form channels for themselves when glacial conditions had passed away, certainly did not follow the old beds.

After the river receives the water from its many tributaries in the Rocky Mountains, it is augmented very little by local streams because of the low precipitation in the area. From source to mouth, the river drops from an altitude of over 5,000 feet to 1,500 feet at its junction with the North Saskatchewan. The river has cut down its valleys and banks very deeply and, in general, falls below the average level of the surrounding land.

The deeply trenched river valley is in general two miles wide, with banks 200 to 300 feet high. As the stream winds from one side of the valley floor to the other, it is alternately working away one bank and building up a large flat on the other. This has created the relatively steep cliffs on one side and a broad river flat a mile or so long and up to half a mile wide on the other. Where the river debouches from one level to a lower one, it has cut a long deep trench. The marked depression cut by the river through the Coteau is particularly notable around Medicine Hat, with the banks being 500 feet high or more.

Throughout most of its length the banks of the river are mostly slumped. Badland topography has developed where these banks consist of soft shales. Beyond the Coteau and below the Elbow the banks gradually become lower, while toward the junction they are little more than sandy banks and flat areas beside the river. Many ox-bow lakes occur on the river's old channels.

Except in flood time, the river is quite shallow, varying from three to ten feet deep. The flow is greatest in June, when the glaciers are melting most rapidly and the rains fall in the foothills. Melting snow in the mountains, combined with very heavy rain of long duration in the foothills, may result in floods along the river flats.

Soils

A number of distinctive soil types cross the southern prairie provinces from Manitoba to Alberta in definite ares of varying widths. These are:

(1) Brown Prairie soils
(2) Dark Brown Prairie soils
(3) Black Dark soils
(4) Grey Wooded soils
(5) Transitional soils

Small areas of sand hills occur in the south central part of the watershed. The position of the watershed places it astride a number of these soil belts.

The brown prairie soils occupy 43 per cent of the whole basin or 18,240,000 acres in the central part of the basin from just east of Lethbridge to Elbow. These soils are derived from post-glacial lake deposits and have many heavy clay surface soils, though of granular structure. Natural fertility is high and they resist drought well. Being in a region of light rainfall, there is an absence of continuous moisture between the surface soil and the ground water level, thus preventing the leaching of mineral salts.

The dark brown prairie soils occupy 27 per cent or 11,200,000 acres and run in a 60 mile arc, on the west side of the basin from Lethbridge to Drumheller and on the east side from Elbow to Saskatoon. These were developed under better moisture conditions and a heavier vegetation cover. Many series of this soil type were developed upon silty lacustrine deposits and are underlain at shallow depths by boulder clay.

The black prairie soils occupy 15 per cent or 6,400,000 acres in the northern bulge of the watershed running north from Red Deer and again through the narrow neck of the basin from Saskatoon to the Forks. These soils are among the most fertile in the whole region; decaying roots or grasses have added large quantities of humus to the soil; while absence of much moisture between the surface and watertable prevents leaching of the mineral salts. Depth ranges from ten to fifteen inches. This soil zone contains more organic matter than the other zones.

Coinciding with the foothills and the Rockies in the western part of the basin are the grey timber or grey wooded and transitional soils. These occur only along the extreme west side of the basin and cover only nine per cent or 3,520,000 acres in the watershed. They developed under a woodland vegetation. A thin leaf mould overlies a grey-leached upper horizon, typical of podsols with a shallow depth of from four to twelve inches.

Transitional soils and the rocks of the Rocky Mountain cover only three per cent or a little over 1,000,000 acres in the extreme west side of the basin.

Sand Plains

Within the watershed occur many sand hills which occupy three per cent or 1,280,000 acres of the whole basin. These deposits appear to mark the location of lakes that existed during the final retreat of the Continental glacier. Bar and sand dune formations are the result of sorting action by waves, later spread and modified by wind action. The largest area is north of the Cypress Hills in the Maple Creek-Fox Valley area. Other areas of sandy waste occur near the mouth of Miry Creek, 10 miles east from Red Deer forks, and a few scattered hills six miles north of Medicine Hat.

The above description of the soils of the watershed is somewhat generalized and excludes the marked variations which occur within the various soil belts. A more detailed description would indicate a great complexity of soils, profoundly modified by glaciation and recording the previous existence of glacial lakes, old beaches, moraines, and glacial deposits ranging in fineness from boulders and gravel to clay.

Natural Vegetation

The pattern of vegetation growth, on the southern prairies as a whole, forms like the soil belts, two concentric arcs with the centre of the arcs being on the mid-point of the International boundary in the Province of Saskatchewan. Encircling these two belts and extending far to the north are the northwestern coniferous forests. They reach southward through the extreme western part of the watershed. Far to the north this type of vegetation merges with the sub-arctic forests.

The wider arc which lies further south contains what is designated as the short grass prairies. It covers the bulk of the watershed area, 66 per cent or 43,000 square miles. Low moisture conditions have resulted in a sparse vegetation cover, consisting of the short grass species. Such species on blue grama grass, june grass and spear grass are common. The whole area is almost devoid of trees except fringes along many of the rivers and lakes.

Further north lies the area of tall grass prairies, often referred to as the Park Belt. This belt enters the watershed along the line of the western-most foothills, and again at the narrow neck of the watershed. Within the basin are 13,000 square miles, making up 20 per cent of the watershed area. The dominant vegetation cover in this belt is the tall grass species and the aspen and poplar woodland growth. Such tall grass species as northern wheat grass and rough fescue, brome grass and reed grass, thrive under the better moisture conditions. The woodland growth within the Park Belt occurs on bluffs interspersed throughout the area. Such trees as aspen, black poplar, Saskatoon berry and various willows are common.

The northwestern coniferous forest zone occupies 9,500 square miles or 14 per cent of the drainage area, in an area 60 miles wide in the extreme west of the drainage basin and coincides with the eastern slopes of the

Rocky Mountains. The dominant trees are poplar, spruce, jack pine, tamarack, willows and canoe birch.

Climate

The location of the Canadian prairies in the interior of a large continent does not allow much variety of climate. The north-south direction of the high mountains along the Pacific coast results in relatively little of the heavy rainfall reaching far inland. The relatively uniform nature of the topography on the prairies makes for a comparatively uniform climate throughout its length and breadth. However, such differences of climate as do exist, from south to north and from east to west, have had considerable influence on natural vegetation and in turn on the soils under which they developed.

Around Medicine Hat is one of the driest districts of Canada for the total rainfall is only 12·75 inches. Towards the north part of the watershed, near Red Deer and Saskatoon, the precipitation varies from 14 inches to 20 inches and is distinctly wetter than the short grass area to the south. Such trees as poplar and some maple and ash grow under the better rainfall regime and the native grasses are of the tall grass species. The precipitation falls during the growing season; the rainy period being June in the south and gradually advancing to July in the north. The watershed area between Lethbridge and Swift Current has less than nine inches of summer rainfall.

Rainfall deficiency is perhaps the most important single fact confronting the farmers on the Canadian plains. In most years, the rainfall is deficient only in the sense that it is not adequate except for drought resisting crops on land tilled by moisture-conserving methods. In the South Saskatchewan watershed area, moisture supply depends as much on the rate of evaporation as on the rate of precipitation. Again, effectiveness of precipitation in this area depends on the amount which falls during the growing season. Climatic information is customarily stated in terms of averages and normals. In the South Saskatchewan area the normal occurrence of rain is less important than the departures from normal. For example, at Medicine Hat the range of precipitation is from a low of 6·38 inches to a high of 25·28 inches. Here the range is 147 per cent of the average—as compared with about 16 per cent in parts of the St. Lawrence Valley. As W. J. Waines points out "over a considerable portion of the area in 40 to 60 per cent of the years, warm-season rainfall is below the minimum necessary for successful agriculture". The agricultural economy in this area, therefore, is focussed on the conservation of moisture.

The whole basin has 120 frost free days and is well south of the 32° F. isotherm, marking the average annual temperature. The average temperature in December, January and February, the coldest months, is 10° above zero, and in June, July and August, 65°. In the summer, days are hot, running as high as 90°, but the nights are for the most part cool.

The river freezes over towards the end of October and the ice breaks up near the end of April. This period corresponds closely to the time when the winter snow is lying on the ground.

Summary

The South Saskatchewan watershed is the outstanding geographical feature of the southern Canadian prairies. Its southernmost location, as part of the larger drainage system of the Saskatchewan River, gives rise to certain physical differences between it and the North Branch. However, looking at the drainage area of the South Saskatchewan as a unit in itself, physical conditions are surprisingly uniform, in spite of its considerable extent.

In general, the physical conditions within the watershed are those of horizontal geological structure, level relief with average elevations of 2,500 feet above sea level, soils formed on glacial material and under a natural vegetation cover of short grass, deeply cut river valleys, and semi-arid to sub-humid climatic conditions. These are the factors which make up the physical pattern within the basin and give it a characteristically uniform nature throughout.

Three geographical facts are outstanding in the South Saskatchewan watershed. They are: the rainfall deficiency throughout most of the area; the constant sources of the river in the glacier fields of the mountains; and the relatively level nature of the relief.

From the point of view of physical geography these factors represent, when considered together in their various interrelationships, the principal physical basis of the watershed area.

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Some Present and Potential River Uses[2]

White men first used the Saskatchewan River and its tributaries some hundreds of years ago—as a transportation route. But it was only about fifty-five years ago that attention was given to development of its waters in other beneficial ways. The first

[2] This section is based on "Full Development Possibilities in the Saskatchewan River Basin", prepared for the Commission by the Hydrology Division, P.F.R.A., Regina, Sask.

major irrigation project was started in 1901, while the first maj r hydro-electric plant was built in 1911. Earlier irrigation and hydro-power projects existed, but these were small.

Prior to 1930, the Government of Canada had control over the investigation and development of the water resources in the whole of the Saskatchewan River basin. During this period a complete hydrometric, irrigation, reclamation and water power service was carried on. The administration of water resources was handed over to the provinces in 1930.

Uses of Water: The demand for water is the summation of the quantities used for domestic, municipal, industrial, irrigation and other purposes. In order to ensure that legal rights to water will not exceed supply, the Provinces of Alberta, Saskatchewan and Manitoba have their respective acts governing water rights which regulate the use of water and set out definite priorities for the various types of uses.

PROVINCIAL PRIORITIES GIVEN TO VARIOUS WATER USES

Order of Precedence	Alberta	Saskatchewan	Manitoba
1	Domestic	Domestic	Domestic
2	Municipal	Municipal	Municipal
3	Industrial	Industrial	Industrial
4	Irrigation	Irrigation	Irrigation
5	Water power	Other like purposes	Other purposes
6	Other purposes	Mineral water purposes	
7	.....	Mineral recovery purposes	

The need for domestic water has steadily increased with population growth and the evolution of agricultural practices. The relationship between domestic use and population growth is obvious. The relationship between domestic use and changes in agricultural practices may require some explanation. As settlement increased and agriculture became more intense, more intensive use was made of grazing lands, requiring conveniently located stock-watering pools. As a result, farm ponds, dugouts and stockwatering dams have been constructed in great numbers. Although the number of these projects is large, the consumptive use of water is far less than that used for municipal, irrigation, industrial or other purposes. The use of water for municipal purposes is a direct function of urban population. Effective consumption is about 20 gallons per day per capita. Assuming an urban population of 500,000 served by the South Saskatchewan River and its tributaries, this amounts to a demand of 20 c.f.s., which is relatively small. However, stream sanitation demands a much larger flow to maintain proper dilution of sewage and industrial wastes in order that domestic and municipal water rights may be protected.

The principal consumptive demand for industrial water on the prairies is for the production of steam power (both railway plant and central generating stations). Railway requirements for steam locomotives and roundhouse boilers are met largely by small reservoirs located on tributary streams in the basin.

Irrigation is now, and will be in the future, the largest consumer of water in the South Saskatchewan basin. The greater part of

the settled prairie region receives less rainfall than is required for the continuous production of crops. "Dry farming" has been successfully adapted to the heavier soils in the region, but many of the lighter soils are either used for marginal or sub-marginal dry farming or for grazing livestock. Many of these light soil areas produce excellently under irrigation.

Water requirements for irrigated tracts vary from soil to soil and from area to area because of physical soil properties and climate. The type of crop grown also influences the requirement or "duty" of water required for the area. However, 18 inches is generally taken as the depth of water required for the production of most crops under irrigation on the prairies. This does not include seepage, evaporation and other losses.

The production of hydro-electric power does not ordinarily require consumptive use of water except for very minor evaporation loss. The effect of hydro development on a stream is to increase stream flow during peak power loads, and to decrease stream flow (through storage) during low power loads. Since peak power loads occur during the winter, peak stream flow (other than spillway discharge) occurs at this time. Such waters can be utilized for irrigation only through additional storage. However, fairly constant summer power loads help to maintain a good summer flow which is of considerable value to irrigation development.

Other purposes include uses such as the creation of reservoirs for recreation, wild life, migratory fowl, mineral water purposes, mineral recovery purposes, etc. The use of water for mineral recovery purposes has not amounted to a great deal to date, but it may in the future. The recovery of potash, maintenance of oil field pressures and recovery of sodium chloride and other soluble salts from deep wells is assuming more importance in the West. However, the total future use will probably be small compared with other demands and may be supplied largely from local and ground water.

The question of protection of "navigable waters" should probably be discussed as one of the "other uses". There exists a Federal Act respecting the Protection of Navigable Waters which contains regulations dealing with construction of works, disposal of wastes, etc., insofar as they affect a navigable stream or other bodies of water. However, the Act does not define "navigable waters". At present, navigation is confined to a short stretch of the Saskatchewan River extending upstream from The Pas. Log driving and shipping of sawn lumber by barge are the only industries which are using the river as a "navigable one".

This river system may be separated into six natural geographic regions as follows: the mountain and foothill area, the western prairies, the central prairies, the delta area, the lakes region and the Nelson River itself. An outline of the potentialities of the Saskatchewan-Nelson River Basin must await a full examination into the needs and interests of each region, an analysis into the compatibility or otherwise of these needs, and a comprehensive study of integration on a complete watershed basis. In the follow-

ing description of existing projects, a brief indication of the most reasonable proposals for future development has been included.

Mountain and foothill region

This first region consists of the eastern slopes of the Rocky Mountains in Alberta and Montana. While this portion of the basin is not the largest in area, it supplies, particularly in dry years, the major portion of the runoff. In the mountains the streams have a slope of from 20 to 100 feet per mile while in the foothills the slope ranges from five feet to 20 feet. There is relatively abundant water in this region for local developments. The land form ranges from steep to hilly to rolling and is generally well forested. Forest conservation, hydro-electric power generation and storage now exist and will probably remain the primary developments in this region.

Forest protection and use in this region in Canada are undertaken by two different agencies. First is the Department of Resources and Development which administers the three national parks (Jasper, Banff and Waterton Lakes) located in this area. The second agency is the Eastern Rockies Forest Conservation Board—a Dominion-Provincial body which administers the former Rocky Mountains Forest Reserve.

Hydro-electric developments are confined to Calgary Power Ltd's developments in the headwaters of the Bow River, except for one or two other very small plants of less than 500 H.P.

EXISTING HYDROPLANTS IN THE MOUNTAIN AND FOOTHILL REGION

Hydroplant	Year built	H.P. Capacity
Horseshoe Falls	1911	20,000
Kananaskis Falls	1913	24,000
Ghost	1929	37,450
Cascade	1942	23,000
Barrier	1948	16,000
Spray	1951	62,000
Three Sisters	1951	3,600
Rundle	1951	23,000

Headwater storage is provided by Calgary Power Ltd. for its system as follows:

EXISTING STORAGE IN THE MOUNTAIN AND FOOTHILL REGION

Storage development	Year built	Storage capacity ac. ft.
Lake Minnewanka	1912	44,000
	1942	180,000*
Ghost	1929	75,000
Upper Kananaskis L.	1932	40,000
	1942	100,000*
Barrier	1948	29,000
Spray Lake	1951	210,000

* Final.

These are the only major storage reservoirs in this area except for the City of Calgary's Glenmore Dam on the Elbow River storing 20,000 acre-feet.

Irrigation in this region is limited to five small projects in the extreme southwest corner of Alberta. Water is supplied from the Belly, Waterton and Oldman Rivers.

EXISTING IRRIGATION IN THE MOUNTAIN AND FOOTHILL REGION

Project	Year started	Irrigated acres	
		Now	Ultimate
United Irr. District	1921	21,000	34,000
Mountain View Irr.	1925	3,600	3,600
Leavitt Irr. D.	1943	2,500	4,400
Aetna Irr. D.	1945	50	7,300
MacLeod Irr. D.	1948	500	10,000

There is no navigation in this area. Some of these streams, however, are used for driving logs, but in terms of river use, this is negligible.

With the recent completion of the St. Mary Dam, Canada is now in a position to utilize its share of the St. Mary River which rises in the U.S.A. and is the most southerly tributary of the Saskatchewan River. Water of the Belly River not required for the four local existing irrigation projects (United, Mountain View, Leavitt and Aetna) will be utilized for irrigation on the St. Mary-Milk River Development (S.M.M.R.D.).

In a similar manner, all the water in the Waterton River, upstream from the point of diversion, will be used on the S.M.M.R.D. For this purpose, it is proposed to construct a storage reservoir having a capacity of 130,000 acre-feet just downstream from Waterton Lake.

The low and ordinary flows of the unregulated Oldman River and its tributaries are now almost fully utilized for the existing irrigation projects downstream. Further expansion of irrigation in this tributary basin must await construction of upstream storage reservoirs. Feasible reservoir sites are tabulated below. If and when this stream does become regulated, a number of additional possible water power sites may then become of economic value; except that here, as elsewhere, hydro-electric developments could conflict with irrigation.

The upper reaches of the Highwood River and its tributaries are not used at present, and there are no natural reservoir sites in its upper basin. Until recently this stream was partially diverted into the Little Bow River to service the Little Bow Irrigation District, but as this district was abandoned in 1950, future diversions should be small.[3]

The headwaters of the Bow River, although well developed at present, are not yet utilized to their fullest extent. Co-ordination of power and irrigation interests on this stream may be desirable in connection with the uses of storage reservoirs. There are several run-of-the-river hydroplants still to be built that would not interfere at all with irrigation.

There are several potential headwater sites in the Red Deer basin which might some day

[3] Works for the Little Bow Irrigation District were constructed in 1923 at a cost of $37,000 to divert a small flow from the Highwood River to the Little Bow River near the town of High River, Alberta. Thirty farmers along the stream obligated themselves to construct their own works and to purchase the necessary pumping equipment. The irrigable area was about 3,000 acres. After the diversion was made, litle interest was shown by the 30 farmers in building the pumping schemes, although the live stream was used for domestic and stockwatering purposes by about 100 farmers along its course. This continued until the organized district was abandoned in 1950, and since then the Alberta government has assumed responsibility for maintaining the diversion.

be used for storage. Here again, as in the Highwood basin, the practicability of operating these for joint irrigation and power purposes remains to be determined.

There is one good site for a storage reservoir in the Clearwater basin. It could prove valuable to assist future irrigation expansion.

additional potential value if and when water is diverted from this stream for irrigation purposes.

The preceding list of potential storage sites in the headwaters of the Saskatchewan River basin indicates there is good reason to hope that the variable flows of the main tributaries may some day be regulated. This

POTENTIAL DAMS AND RESERVOIRS IN MOUNTAIN AND FOOTHILL REGION

Tributary basin	Site	Storage ac. ft.	24-hour capacity H.P.	Purpose
Waterton	Waterton	130,000	.....	Irr. stor.
Oldman	Castle River Canyon	40,000	?	" " and power
"	Castle River	30,000	?	" " "
"	Oldman Gap	90,000	?	" " "
"	Willow Cr-Pinepound	26,000	?	" " "
Bow	Lac des Arcs	500,000	12,000	" " "
"	Russell	50,000	20,000	Power
"	Radnor	7,000	13,000	"
"	Glenbow	25,000	21,000	"
"	Bearspaw	20,000	12,000	"
"	Lower Kananaskis	90,000	.....	"
"	Pocaterre Cr	.....	?	"
Red Deer	Douglas Lake	60,000	.....	Irr. stor.
"	Red Deer No. 1	140,000	.....	" "
"	Red Deer No. 2	20,000	.....	" "
Clearwater	Clearwater Gap	160,000	.....	" "
North Sask	Glacier-Waterfowl	70,000	.....	Irr. and power st.
" "	North Sask. Gap	1,000,000	?	" " "
" "	Whirlpool	250,000	8,000	Power
" "	Tershishner	200,000	10,000	"
" "	Cardinal R	75,000	8,000	"
" "	Nordegg	40,000	4,000	"
" "	Rocky Rapids	300,000	20,000	"
" "	Carvel	400,000	20,000	"

The upper reaches of the Brazeau and North Saskatchewan basins offer several sites for storage developments. These could be used for power production, while those upstream from Rocky Mountain House have

hope, however, must be tempered by the following four factors:

Firstly, hydro-electric storage developments may need to be co-ordinated with irrigation developments. Irrigation interests

desire water only in the summer; power interests require the use of less water in the summer and more in the winter. This conflict of interests could conceivably delay or obstruct the development of these headwater storage sites.

Secondly, for foundation and water supply reasons, it appears likely that after the upper Bow River is fully developed, the next basin to be built up into a power stream will be the Athabaska—completely outside the Saskatchewan River basin.

Thirdly, thermal-electric plants utilizing natural gas or strip coal may tend to become competitive with the more expensive hydro-electric sites in this region.

Fourthly, the National Parks Bureau of Canada, which administers the National Parks, discourages the construction of dams and reservoirs within Banff and Jasper National Parks. The full use of these streams will require a more liberal policy with respect to applications for the diversion and use of these waters.

Western Prairie Region

East of the foothills is the western prairie region lying generally in central Alberta. It is characterized by moderate river gradients, river banks usually 100 feet or more in height, a semi-arid climate and generally flat to rolling topography. This combination has allowed the development of gravity irrigation in those locations having good irrigation soils.

Irrigation developments are by far the most important uses of water in this region.

EXISTING IRRIGATION
IN THE WESTERN PRAIRIE REGION

Project	Year started	Irrigated acres	
		Now	Ultimate
St. Mary-Milk River Project..	1901	150,000	495,000
Western Irrigation District....	1908	50,000	50,000
Eastern Irrigation District....	1914	200,000	281,000
Lethbridge Northern Irrigation District.....	1922	75,000	90,000
Bow River Irrigation District (C.L. and I. Co.).....	1918	50,000	240,000
Small private projects.....	.....	50,000?	70,000

EXISTING MAJOR STORAGE
IN IRRIGATION PROJECTS

Irrigation Project	Reservoir	Capacity in acre feet	
		Now	Ultimate
St. M.M.R.D.....	St. Mary reservoir...	270,000	270,000
"	Chin.....	50,000	150,000
"	East Pothole.....	14,000	14,000
"	Ridge.....	.....	80,000
"	Verdigris.....	.....	110,000
"	Waterton.....	.....	130,000
Eastern I.D.....	Lake Newell.....	90,000	100,000
Bow R. I.D.....	Lake McGregor.....	75,000	200,000
"	Traverse.....	.....	20,000
"	Little Bow.....	20,000	20,000
Leth. Nor. I. D...	Keho Lake.....	40,000	40,000

It should be noted that these irrigation projects are limited to the southern tributaries of the Saskatchewan River. No major irrigation developments as yet exist north of the Red Deer River.

No hydroplants exist in this region, although at one time there was a 700 H.P. plant near Calgary and another of 180 H.P. installed in the C.P.R.'s bassano Dam. These have proved to be uneconomical. Industrial uses, especially on the North Saskatchewan River near Edmonton, are becoming increasingly important due to industrial growth.

Of the existing large irrigation projects, only the Western Irrigation District is fully

developed. The other projects are steadily expanding towards their full authorized development. When this occurs, practically all but the winter and flood flows will be completely utilized in the whole of the Bow and Oldman River basins (i.e. upstream from Medicine Hat). This indicates that no further major irrigation projects can be initiated in this region on or south of the Bow River. Of course, there are possibilities of developing some new small irrigation projects where the local water supply is sufficient.

This leaves the Red Deer and North Saskatchewan basins with potentialities for large irrigation development in this region.

It is unlikely that the North Saskatchewan basin will ever need large-scale irrigation within its drainage area—its climate appears satisfactory for successful dry land farming.

On the other hand, large areas in the Red Deer basin are suitable for irrigation. Present plans call for a high dam on this river near Ardley to store and divert irrigation water and produce supplementary hydro-electric energy. Red Deer River water alone could only irrigate 300,000 acres and produce 5,000,000 k.w.h. annually, or alternatively, irrigate 100,000 acres and produce 35,000,000 k.w.h. annually. An additional 200,000 acres could be irrigated if the summer flows of the Clearwater River were diverted into the Red Deer River. A further 300,000 to 400,000 acres could be irrigated if North Saskatchewan water were diverted into the Red Deer River utilizing, in part, the Clearwater diversion route. Thus, there is sufficient water available to irrigate over 600,000 acres of land in the Red Deer and adjoining basins providing (a) there are sufficient good irrigable lands to utilize this amount, (b) there is sufficient storage available to regulate this water, and (c) that trans-basin diversions meet with no opposition.

With regard to point (a): the upper Sounding Creek-Berry Creek area of this region probably contains about 300,000 irrigable acres. This area is known as the proposed Red Deer Irrigation Project. It is believed that an extension of the main canal, crossing into Saskatchewan near the town of Loverna, could serve an additional 200,000 acres in the central prairie region. It therefore appears that 500,000 acres is the maximum acreage that could be irrigated without running the canals an excessive distance with corresponding excessive losses. It should be pointed out, however, that very little information is available on this proposal. To irrigate these 500,000 acres it would only be necessary to divert the Clearwater River without further diversion from the North Saskatchewan. This would mean that only a relatively small amount of hydro-electric energy could be developed at the Ardley Dam.

With regard to (b): there are sufficient potential storage sites to regulate the water for the purposes of this project. These are, in addition to the potential sites in the mountain and foothill region enumerated previously, as follows:

Name of Site	Capacity acre-feet	Purpose
Raven	150,000	Irrigation storage and power
Ardley	300,000	" "
Buffalo Lake	300,000	Irrigation storage
Craig and Hamilton	250,000	" "
Grenville	250,000	" "

Throughout this region there are some small potential irrigation projects not already mentioned.

Tributary Basin	Project name	Irrigable acres
Oldman	Todd Creek	8,500
"	Pincher Creek	16,000
"	Beaver Creek	2,500
"	Cowley	3,000
"	Granum	4,500
"	Carmangay	12,000
Highwood	Champion	50,000

Of these potential irrigation projects, it is probable that, at the most, only 40 000 acres would ever be developed because of various climate, soil, water supply or economic factors.

There are other schemes on the two tributaries rising in the Cypress Hills, but these are small and, for the purpose of this review, negligible.

Central prairie region

In this region, the major Saskatchewan River tributaries flow through deep valleys and have relatively flat gradients. In the middle of the region (South Saskatchewan Development area) the climate, soil and topography are practically identical with those of the western region. The deep river valleys make it impracticable to construct high dams for gravity irrigation alone or for the development of hydro-electric power alone. Where, however, it is possible to combine these two uses, the development may become desirable. In such a case, the deep valleys and flat gradients would provide a very large amount of storage.

Farther downstream, the North and South Saskatchewan Rivers and the Saskatchewan River become steeper with some rapids. Hydro-electric power projects, even if aided by upstream regulation, are marginal in these stretches of the rivers.

Irrigation on the main rivers has not developed as yet. However, some irrigation does exist on the tributaries and on the river flats. The Qu'Appelle River valley, which lies adjacent to the South Saskatchewan watershed, offers possibilities for the development of water for a variety of important uses. The Qu'Appelle River has its source near the South Saskatchewan River, at the town of Elbow. It runs in an easterly direction for some 250 miles, joining the Assiniboine River approximately 10 miles east of the Manitoba-Saskatchewan boundary. Throughout most of its length the valley bottom is broad and flat, and large areas are suitable for agricultural purposes. Because of the flat gradient, the river has formed six large lakes in the valley.

At present approximately 40 per cent of the land in the Qu'Appelle Valley is under cultivation, the major part of which is in ordinary field crops. Irrigation on a small scale is practiced by some market gardeners near the town of Craven.

Future demands on the water of the Qu'Appelle River will be from three sources: (1) use of Buffalo Pound Lake by the cities of Regina and Moose Jaw for domestic water supplies; (2) further irrigation of the valley flats; and (3) maintenance of the lake levels for water supplies and recreation.

The Qu'Appelle River itself does not have sufficient water to meet these demands, and for future developments it will be necessary to obtain water from an outside source. The South Saskatchewan River is the only practical source from which to obtain this additional water.

One method of delivering water to the valley is through works of the proposed South Saskatchewan River Project. Here the water could be released from the Meridian Dam to flow by gravity the 20 miles to Buffalo Pound Lake. A second method is by pumping at "the Elbow" on the South Saskatchewan River, and delivering the water by 52 miles of canals and natural channels to Buffalo Pound Lake.

It is estimated that by the year 1980, the combined population of the cities of Regina and Moose Jaw will have reached 130,000 persons. In this year these cities will be drawing the major portion of their domestic water supplies from Buffalo Pound Lake. Natural runoff will provide only part of this demand of possibly 10 million gallons daily. Water supply studies indicate that in an average year 18,500 acre feet of water will have to be obtained from the South Saskatchewan River to augment natural supplies. This demand would reach a peak of 33,000 acre-feet during a year of low runoff.

There are about 30,000 acres of land in the valley which are suitable for irrigation. The inflow below Buffalo Pound Lake is sufficient to irrigate only 6,000 acres. Water from the South Saskatchewan River would be required for the remaining 24,000 acres. This average annual requirement will be 23,000 acre-feet and the maximum requirement 27,500 acre-feet in any one year.

The Qu'Appelle Lakes in the vicinity of, and downstream from, Fort Qu'Appelle will be kept full by the irrigation water passing through them. Last Mountain Lake, is therefore, the only lake requiring further water for maintaining the water level.

Last Mountain Lake levels have ranged from a low elevation of 1598 to a high of 1612. By adding 25,000 acre-feet annually from the South Saskatchewan River in average and low-water years it would be possible to prevent this lake from falling below elevation 1605. No water would be required in wet years.

Summarizing these results, it can be seen that in order to have sufficient water in the Qu'Appelle watershed to meet demands for municipal water supply, and irrigation and maintenance of lake levels, an average of 66,500 acre-feet of water annually, and a maximum of 85,500 acre-feet will have to be obtained from the South Saskatchewan River to supplement the natural flow of the Qu'Appelle River.

A pumping plant and delivery canal with a capacity of 220 c.f.s. will supply the required water from the South Saskatchewan River. The works will have to be operated continuously for an average of 5 months each year. During a year of low runoff the works will have to be operated 6½ months.

It is estimated that a pumping plant and delivery canal of this magnitude will cost $1,500,000 to construct, while the average annual operation, maintenance and depreciation charges will be $200,000 each year. These amounts do not include the cost of developing irrigation in the valley, but are

the cost of stabilizing the water supply with water from the South Saskatchewan River by the pumping method.

EXISTING IRRIGATION
IN THE CENTRAL PRAIRIE REGION

Project	Year	Irrigated acres	
		Now	Ultimate
Swift Current Irr. Dis.....	1940	7,500	21,000
French Flats—Valley Park...	1940	700	6,500
Small private projects.....	.....	4,000	8,000

In 1912, construction of La Colle Falls hydro-electric plant on the North Saskatchewan was started but never finished. It is now abandoned. It is unlikely that further hydro developments will ever be initiated on this stretch of the river. Irrigation from the North Saskatchewan River is also unlikely because (1) dryland farming is fairly successful in the immediate area, and (2) high pumping lifts would be required from the river. The future use of the *North* Saskatchewan River will include in addition to the possible Clearwater diversion, municipal and industrial uses near Edmonton and some very minor irrigation schemes, and possible hydro-electric developments on the head waters.

POTENTIAL HYDROPLANTS
IN THE CENTRAL PRAIRIE REGION

Basin	Name	Installed capacity K.W.	Storage Acre-feet
South Sask.....	South Sask. R.P.....	150,000	3,900,000
" "	Batoche.....	40,000	
" "	Coxby.....	40,000	
Saskatchewan..	Fort à la Corne.....	100,000	230,000
" ..	Nipawin.....	100,000	230,000
" ..	Squaw.....	50,000	

POTENTIAL IRRIGATION
IN THE CENTRAL PRAIRIE REGION

Project	Irrigable Acres
Swift Current extension.....	14,000
Red Deer extension.....	200,000
South Saskatchewan R.P.....	450,000

Other uses of water in this region will be small. Additional major irrigation developments are possible but improbable.

Delta area

Between the prairie and lake regions, the Saskatchewan River flows through a broad flat valley which is generally lightly wooded, but which is dotted with numerous shallow lakes and large open marshes. The soil, being built up through the years by silt deposition, is very rich. With reclamation, this area may have excellent agricultural possibilities. Navigation and log-driving, upstream from The Pas, are present.

In 1940, the rehabilitation of muskrat breeding grounds, dependent on annual flooding from the Saskatchewan River, was encouraged. This type of development, however, is being gradually supplanted and destroyed by the more desirable and increasing uses that are being made of the rich delta soils for agricultural purposes.

There is no prospect for either irrigation or hydro-electric developments in this region. Water transportation and log driving will continue to use the river without interference from artificial controls. The higher lands west of The Pas are being increasingly

occupied for agricultural purposes. The possibility of reclaiming the lower-lying lands was first surveyed in 1911 and is presently being investigated.

The delta is situated in the vicinity of the Saskatchewan-Manitoba boundary. It is bounded by Cumberland Lake and the Saskatchewan River on the north, the Carrot and Pasquia Rivers on the south, and extends westerly from The Pas, Manitoba, a distance of 85 miles. Most of the land is low-lying and marshy, with the general elevation of the area about that of the summer water levels in the bordering rivers. There is a gentle slope from about elevation 900 at the western end to 850 at The Pas. Generally, the river banks are relatively high and support a heavy mixed forest growth. Inland, the land drops away and the forest gives way to willows, and open grass land and marsh occupy about 80 per cent of the 4,000,000-acre area.

The low-lying nature of the land and poorly developed drainage confine the present land use mainly to lumbering and trapping. Works for flooding much of the area have been built by the Government of Manitoba, the Hudson's Bay Company, and the Indian Affairs Branch for the purpose of increasing the muskrat population. Periodically the Saskatchewan River overflows its banks from near Cumberland House on Cumberland Lake, to The Pas, inundating tive to diverting the Pasquia River would with the poorly developed drainage, has resulted in most of this fertile land becoming marshy and unfit for cultivation.

About 1,000 acres of the higher lands along the Pasquia and Carrot Rivers are patented lands, and have been cultivated successfully for many years. In recent years, settlers have leased and broken some 15,000 acres of additional land, and where water levels permit, cattle are grazed on the uncultivated area.

As early as 1915 investigations had been made of the Saskatchewan delta region to determine the feasibility of reclaiming the area by protective dyking and drainage. In more recent years soil surveys and economic studies have been done of some sections of the region.

The preliminary survey of that area of the delta which lies between the Carrot and Pasquia Rivers, and extends from The Pas to the Saskatchewan-Manitoba boundary, has been completed. This tract is known as the Pasquia area, and being separated from the remainder of the delta by the Carrot River, can be reclaimed independently of the region as a whole. The Pasquia area contains about 135,000 acres of which 16,000 are now being cultivated, and about 5,000 more used for hay and grazing.

The P.F.R.A. surveys and engineering studies of the Pasquia area show that the construction of 22 miles of dyke, with a maximum height of eight feet, and diversion of the Pasquia River into the Carrot River near the Saskatchewan-Manitoba boundary, will prevent further flooding. An alternative to diverting the Pasquia River would be the construction of an additional 30 miles of dyke along its west and north banks.

Drainage of part of the area can be accomplished by open ditch drains and pumping stations. The remainder of the area can be drained into lake storage during the high water periods; this storage would be released every fall when the river is normally low.

If flood protection and drainage is provided, an estimated 96,000 acres will be suited for cultivation and an additional 10,000 acres to hay and grazing uses.

The cost of the works necessary to reclaim the land in this area has been estimated by the engineers carrying on the present investigation at $1,350,000, or about $13.50 per acre. No recent estimate of cost has been made for reclaiming the remainder of the Saskatchewan Delta Region.

At present easily accessible and under-supplied markets are available at The Pas and Flin Flon, a relatively short distance from the source of supply. With the development of marketing facilities and improvements in transportation, this market might absorb the produce during the initial stages of development.

To the east of The Pas the river flows through more marshland. The reclamation of this area, from The Pas to Cedar Lake, can be accomplished by lowering Cedar Lake by improving its outlet, by further river channel improvement and by the construction of levees and interior drains. This would reclaim at least an additional 500,000 acres. This proposal, however, is expensive and would be in conflict with the proposed Dauphin River power project.

At one time there was a proposal to build an hydro-electric plant, having a head of 80 feet, just at the mouth of the Saskatchewan River at Grand Rapids. This plant may never be built as it is in direct conflict with both the Dauphin River power project and the reclamation project east of The Pas.

It is possible to divert the Churchill River to the Saskatchewan River via the Sturgeon-weir River. It remains only a possibility.

The Lakes Region

The lowest reaches of the Saskatchewan River pass through and empty into large fresh water lakes that are the remnants of glacial Lake Agassiz. In addition to the obvious uses of logging, navigation, fishing and recreation, the lake system can, by various diversions, be developed for hydro-electric power production.

This is proposed in the Dauphin River Power Project. By constructing a series of canals, dykes, dams and river improvement works, this project can develop about 800,-000,000 k.w.h. of annual firm electrical energy near the mouth of the Dauphin River on the western shore of Lake Winnipeg.

There remains the question of whether it would be more economical to build this project or develop the hydro sites on the Nelson River. If it is found that the Nelson River sites are more desirable, then this Dauphin River Power Project would be, for the foreseeable future anyway, abandoned.

The Nelson River

This river, the outlet of Lake Winnipeg, drains some 450,000 square miles including the Saskatchewan River Basin. The river is entirely unused except for an insignificant amount of summer seasonal traffic.

In its course to Hudson Bay, it falls about 700 feet, of which 550 feet are considered useful for power purposes. Allowing for three feet of useful storage on Lake Winnipeg, the dependable flow has been estimated to be over 44,000 c.f.s.

From 10 to 15 separate hydroplants will be required to utilize the 550 feet of effective

head, two of which are now under active investigation. These are, (1) Whiskey Jack with a head of 30 feet, and (2) Whitemud Falls with a head of 50 feet.

The only deterrent to the development of this river is the considerable distance between the power plants and markets which give rise to high transmission costs and electrical losses.

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