13054

1897 AND 1898

PART VII

IRRIGATION

CANADIAN IRRIGATION SURVEYS, 1897.

J. S. DENNIS, D. T. S.

Member American Society of Irrigation Engineers, Acting Chief Inspector of Surveys, in charge.

Similarly to 1896, the irrigation surveys were carried on under two divisions.

Party No. 1, of Division A, was in charge of Mr. R. W. Macintyre, C.E., who, in accordance with instructions given him, made a rapid survey of the St. Mary River through Townships 3 and 4, to ascertain the feasibility of locating a canal to divert water from that stream at a lower level than the intake located in 1895, in section 36, Township 1, Range 25.

It was found impossible to effect the object in view, owing to a height of land lying between Spring coulee, and Cardston, and the frequent occurrence of precipitous cutbanks along the course of the river in this part

The survey was made with the object of cheapening the cost of construction in conducting water to the Lethbridge plains.

The party next ran certain line levels in the Lethbridge district along the east and west boundaries of Township 2, Range 28, and west boundary of Township 3, Range 28, and also made a survey of a portion of the Waterton lakes; at the same time obtaining a cross-section at the outlet from the lower lake to ascertain the practicability of constructing a dam at this point for the purpose of storing the spring run-off, from the adjacent watershed, in the lakes until required for irrigation purposes later in the season.

On the completion of the above surveys, further instructions, dated 20th of June, were issued to Mr. Macintyre to continue the general outline levels in the Cypress Hills district, commenced the year previous by Mr. James Gibbon, D.L.S., on their northern slopes. Work was begun on the 30th of June, and continued until the 8th of October.

It comprised the running of levels along the township outlines of the lands survey system on the south slopes of the Hills, to obtain some knowledge of the feasibility of diverting the waters of Battle Creek and Cypress Lake to Swift Current Creek, by utilizing the channel of the Whitemud River. Levels also were run and permanent benchmarks placed to establish a base for a future topographical survey of the Cypress Hills watershed.

It was ascertained that water could be diverted from Battle and Belanger Creeks to Cypress Lake at a low expenditure. The former now flows to the Milk River, and the latter to Whitemud River. By effecting these diversions the water level of the lake can be raised at least fifteen feet.

It was originally hoped that water stored in Cypress Lake could be diverted by way of Belanger, and Frenchman Creeks, (the latter, formerly known as Whitemud River) to Swift Current Creek, and so, to the irrigable lands under that stream, where it is badly needed.

Water, however, can only be diverted to the south, and while there are tracts of land lying in that direction that can be served from Cypress Lake as a reservoir, they are neither so numerous nor so valuable as those in the Swift Current district. These facts were ascertained as the results of a careful survey of the Whitemud River, (Frenchman Creek) by Mr. Macintyre. Owing to the broken nature of the valley through which it flows, the small fall of the stream, and the many cutbanks and ravines met with, it was found that the cost of construction and maintenance would be too great to warrant the undertaking of such a scheme at the present time.

Mr. Macintyre closed field work on the 9th of October, and was subsequently employed in the office making up the returns of his survey. Full particulars will be found in the accompanying report of his season's work.

Party No. 2, of Division A was in charge of Mr. Oliver York, C.E., who made exploratory surveys in Eastern Assiniboia for the purpose of locating suitable reservoir sites and storage basins on the different drainage channels in that district, to hold the spring runoff, and thus increase the present supply for domestic and stock watering purposes.

In this section of Assiniboia, all except the few larger streams dry up during the summer months, and water is obtained with great difficulty, in some cases having to be drawn many miles.

The sinking of wells has proved uncertain and costly. An endeavour has been made to meet the difficulty by applying money grants from the Territorial Government to the construction of dams, a large number of which have been built at suitable points along the various drainage channels. Most of the dams have been put in at haphazard, wherever a suitable place to build a dam presented itself, and without proper information as to the drainage area creating the supply and the best interests of the community affected; there was, moreover, no information at hand as to the amount of the spring freshet discharge, or other supply, that could be counted upon to maintain the reservoirs.

In view of these facts, and the great importance of the question with regard to the future of farmers and stock growers settled in this section, it was decided to employ one of the irrigation survey parties to obtain the information required as to discharge, and to locate the most suitable points for building large dams, so that the necessity for the numerous smaller ones could be dispensed with to some extent by the creation of larger, more healthy, and more up to date reservoirs, serving a greater number in a more efficient manner.

The party was organized at Moosejaw, and work commenced on the 14th June.

Sites for dams creating storage basins were located as follows:—One on Moosejaw Creek, two on Cottonwood Creek, one on Wascana Creek, one on Boggy Creek, and one on Manybone Creek.

Some time was spent in examining an existing dam built across the Qu'Appelle River, east of the Fort, and in making a cross-section of the Qu'Appelle valley not far from the eastern end of Buffalo Lake. It was ascertained that a dam built at this point to a mean height of seven feet, and three-quarters of a mile long, would raise the water level of the lake 4 feet.

The party closed field work on the 6th of October. Mr. York was subsequently employed in the office making up his survey returns. A detailed report will be found embodied in the transactions of Division A.

Division B of the surveys, under the charge of Mr. A. O. Wheeler, D.L.S., continued the topographical survey of the foothills district and eastern slopes of the Rocky Mountains forming the watershed for the streams flowing eastward through the irrigable lands of Alberta.

The survey was conducted as in the past, the photographic camera and mountain transit being used to record the topography, supplemented by micrometer traverses of the main streams, and their larger tributaries.

Numerous omissions in the programme of the two previous seasons, caused by smoke from forest fires, were supplied and the work completed in the Sheep River basin.

The survey was also extended over a considerable portion of the Highwood River basin.

A micrometer traverse was carried up Highwood River to its source, where a tie was made with the micrometer traverse of the previous season up the Elbow River; also up Cataract, Pekisko and Stimson Creeks to their heads.

Up to the present, the primary, and secondary triangulation upon which the photographic work is based, has been expanded southward from one of the sides of D.L.S. Drewry's triangulation up the Bow Valley. An independent base was now selected, on the flat above the bed of Highwood River, and a preliminary measurement made. The

necessity of closing down the field work of the Division prevented the final measurements and expansion from the base being completed.

Mr. Wheeler's report under the heading "Division B," fully covers the work performed during the season.

SCHEDULE of Bench Marks established by Division A Party No. 1 in 1897.

No.	Location.	Sec.	Tp.	Rge.	West of Meridain.	Elevation.
260	8·26 chains S. of N.E. corner of	13	8	3	4	4553·30
261	North-east corner of		7	2	4	4600·63
262	22·03 chains S. of N.E. corner of	13	5	3	4	3710·00
263	45 chains E. of N.E. corner of	34	4	2	4	3552·93
264	Not established. Bar planted but overlooked					
265	142 feet N. of base line oppo 45 chs. East of N.E. cor. of	34	4	30	3	3349·56
266	North-east corner of	34	4	27	3	3074·11
267	North-east corner of		4	26	3	3054·86
268	11 chains E. of S.E. corner of	4	7	25	3	3532·84
269	North-east corner of		7	23	3	3776·64
270	45-92 chains W. of N.E. corner of		7	25	3	3882·65
271	In North-west ¼ of	21	6	24	3	3118·81
272	North-east corner of	34	7	29	3	4381·51
273	5·5 chains N. of N.E. corner of		8	23	3	3767·86
274	5·5 chains N. of N.E. corner of		8	23	3	3767·86
276	66 feet N. of a point 35 chains W. of N.E. corner of	2	10	24	3	3573·03

All the bench marks enumerated in the above schedule were planted by party No. 1, under Mr. R. W. Macintyre. They were placed at points selected along the lines levelled over, for future reference, when making a topographical survey of the Cypress Hills watershed.

The bench marks were of the same nature as those that have been previously placed along the levelled township outlines, consisting of the ordinary township corner iron bar used in marking the land surveys. The bar is a pointed iron tube, five feet long, and one and three-eighths of an inch in diameter; it is driven perpendicularly with a sledge to within ten inches of the top. The top is a solid square piece of iron welded to the tube, on which the letters B. M., the broad arrow, and the number are stamped by steel dies.

The elevations of the top of the bar, and the ground at its base are carefully taken and recorded for future use.

SCHEDULE of Mean Temperature for 1897.

——	Swift Current, Assa.	Chaplin, Assa.	Regina, Assa.	Battleford Sask.	Pincher Creek, Alta.	Calgary, Alta.	McLeod, Alta.	Medicine Hat, Assa.
Latitude, N	50° 20′	50° 27′	50° 27′	52° 41′	49° 00′	51° 02′	44° 49′	50° 01′
Longitude, W ..	107° 45′	106° 40′	104° 37′	108° 30′	114° 00′	114° 04′	113° 11′	110° 37′
Elevation.—(Ft. above sea-level.)	2439	2202	1885	1620	3750	3389	3060	2161
January.....	9·6 *a*	2·0 *a*	0·6 *a*	0·1 *b*	18·8 *a*	12·6 *a*	.....	11·5 *a*
February.....	10·5 *a*	4·5 *a*	0·2 *a*	0·1 *b*	22·2 *a*	15·9 *a*	24·4 *a*	11·4 *a*
March	8·7 *b*	6·9 *b*	1·7 *b*	5·1 *b*	.....	11·4 *b*	18·0 *b*	11·3 *b*
April	43·3 *n*	41·3 *n*	38·6 *a*	43·3 *a*	42·6 *b*	43·7 *a*	46·2 *a*	47·4 *a*
May.....	58·5 *a*	57·2 *a*	54·6 *a*	57·7 *a*	56·5 *a*	57·9 *a*	60·2 *a*	62·0 *a*
June	61·2 *n*	60·0 *b*	58·7 *b*	60·3 *n*	52·4 *b*	57·0 *a*	60·6 *b*	61·5 *b*
July.....	65·5 *n*	66·0 *b*	64·4 *b*	62·5 *b*	.....	59·2 *b*	65·4 *a*	65·8 *b*
August.....	67·2 *a*	64·4 *a*	62·8 *n*	64·4 *a*	....	62·7 *a*	71·3 *a*	69·9 *a*
September.....	58·1 *a*	54·9 *a*	58·1 *a*	56·1 *a*	.....	52·4 *a*	57·5 *a*	58·8 *a*
October	43·7 *a*	42·7 *b*	41·2 *a*	43·1 *a*	.....	42·2 *a*	47·6 *a*	45·4 *a*
November.....	15·2 *b*	14·0 *b*	11·9 *b*	10·2 *b*	19·0 *b*	12·3 *b*	17·9 *b*	15·4 *b*
December	14·7 *n*	—6·2 *b*	6·5 *b*	4·6 *b*	21·9 *b*	18·2 *b*	21·8 *b*	18·0 *n*

NOTE.—*a* Above mean average. *b* Below mean average. *n* Normal.

SCHEDULE of Precipitation for 1897.

——	Calgary, Alta.	Medicine Hat, Assa.	Swift Current, Assa.	Chaplin, Assa.	Regina, Assa.	Battle-ford, Sask.	Pincher Creek. Alta.	Macleod, Alta.
Latitude, North	51° 03′	50° 01′	50° 20′	50° 27′	50° 27′	52° 41′	49° 11′	44° 49′
Longitude, West	114° 04′	110° 37′	107° 45′	106° 40′	104° 37′	108° 30′	114° 00′	113° 11′
Elevation. —(Ft. above sea-level.)	3406	2161	2439	2202	1885	1620	3750	3060
January.....	0·53 *b*	0·74 *a*	0·57 *b*	0·40 *b*	0·70 *a*	0·06 *b*	0·00 *b*	.....
February.....	0·46 *b*	0·41 *b*	0·84 *n*	1·00 *a*	0·55 *a*	0·60 *a*	0·50 *b*	0·1
March	0·26 *b*	0·50 *b*	0·24 *b*	0·60 *a*	0·10 *b*	0·16 *b*	0·00 *b*	0·58
April	0·31 *b*	0·39 *b*	0·08 *b*	0·35 *b*	*r*	0·30 *b*	0·47 *b*	1·20
May	0·18 *b*	0·59 *b*	0·26 *b*	.....	0·30 *b*	0·24 *b*	1·20 *b*	.....
June	6·13 *a*	5·62 *a*	0·83 *b*	0·24 *b*	1·97 *b*	3·87 *a*	5·37 *b*	4·20
July	5·54 *a*	1·65 *a*	6·27 *a*	0·24 *b*	1·58 *a*	4·67 *a*	.....	2 16
August.....	2·13 *a*	0·40 *b*	1·28 *b*	0·05 *b*	1·17 *a*	1·57 *b*	.....	0·15
September.....	1·04 *b*	2·15 *a*	2·60 *a*	2·24 *a*	0·51 *b*	3·27 *a*	.....	0·92
October	0·76 *a*	1·26 *a*	0·88 *b*	0·87 *a*	0·84 *a*	0·19 *b*	.....	0·33
November.....	2·54 *a*	3·11 *a*	1·50 *a*	0·74 *a*	1·20 *a*	1·10 *a*	1·24 *b*	2·40
December	0·70 *a*	0·43 *n*	0·89 *a*	.....	0·40 *n*	0·50 *a*	0 09 *b*	0·63
Total.....	20·58 *a*	17·25 *a*	16·24 *a*	6·73 *n*	8·62 *b*	17·23 *a*	8·87 *b*	12·67

NOTE.—*a*, Above mean average. *b*, Below mean average. *n*, Normal.

In the 1896, General Report on Irrigation, and Irrigation Surveys, schedules of mean temperatures and precipitation were compiled for as many years previous as records of any value could be obtained, but not extending back beyond 1883.

The records were compiled chiefly from the monthly weather reviews and annual reports of the Meteorological Service of Canada, with data obtained from the Government observing stations at scattered points situated within the irrigation belt.

These records are now given for the year 1897, in the accompanying schedules, together with the latitude, longitude, and elevation above sea level of the observing stations.

A study of the temperature schedule reveals some interesting facts. At Regina, the most easterly point, six months were above the mean average, two below, and four about normal; at Chaplin, the next point west, five months were above mean average, six below and one normal; at Swift Current, six above average, five below, and one normal; at Medicine Hat, seven above, four below and one normal; at Calgary, eight above and four below; at Macleod, seven above, four below and one not given; at Pincher Creek, of the seven months for which records are given, three were above average and four below. At Battleford, the most northerly point, five above, six below and one normal. January, February, April, May, August and September were generally above the mean average; March, June, July, November and December generally below.

In the schedule above given the letters, *a*, *b* and *n*, indicate respectively *above*, *below* and *normal*.

In the schedule of precipitation the following facts became apparent:—

At Calgary the heaviest precipitation was in June, July and November, with total for the year much above the average and the greatest in thirteen years.

At Medicine Hat, in June and November, with total much above the average and, excepting that of 1896, the greatest in fourteen years; the precipitation for 1896 was 18·18 inches.

At Swift Current, in July and September, with total very slightly above average.

At Chaplin, in September, with total about average.

At Regina, in June, July and November, with total slightly below average.

At Battleford in June, July and September, with total considerably above and greatest in five years.

Pincher Creek has no records for July, August, September and October, and Macleod has not been previously noticed in the irrigation reports in the matter of precipitation.

In the schedule the letters *a*, *b* and *n*, indicate *above*, *below* and *normal*.

The Meteorological Office reports show no return of temperatures and precipitation at Gleichen, or Maple Creek for 1897.

DIVISION "A" PARTY No. 1

R. W. MACINTYRE, C.E., IN CHARGE.

DEPARTMENT OF THE INTERIOR,
SURVEYS AND IRRIGATION,
CALGARY, 6th December, 1897.

J. S. DENNIS Esq., D.T.S.,
Acting Chief Inspector of Surveys and Irrigation.

SIR,—I have the honour to submit the following report of field work accomplished by Party No. 1, of Division "A", from 10th May to 8th October, 1897.

ST. MARY'S CANAL.

In accordance with instructions received from you, my party proceeded by trail from Calgary (via Macleod and Lethbridge) to Cardston, where a rapid survey of the St. Mary River was made, with a view to determining the feasibility of a low level irrigation canal, as opposed to the high level scheme, surveyed in 1895, by Division "A."

Commencing at a point above the bridge on the St. Mary River, in Section 8, Township 3, Range 24, west of the 4th meridian, levels were taken down stream to Section 12, Township 5, Range 24, west of 4th meridian, the elevation of water level and bench land along the river being compared at frequent intervals.

Owing to the constant recurrence of cut-banks, and the topographical features of the bench land, it was found impracticable to locate a low level line of canal from the St. Mary River.

WATERTON LAKES.

A transit transverse, with accompanying levels was commenced at the intersection of the Waterton River with the north boundary of Township 2, Range 29, west of 4th meridian, and continued up river on the west shore to the narrows between the middle and upper (or southernmost) of the Waterton lakes.

At this point further progress was arrested by the mountain side, which forms an almost vertical wall of rock around the lake. The traverse and levels were continued from a point on the north boundary of Section 32, Township 1, Range 29, west of 4th meridian on the east side of the lower (or northermost) lake, and connected with station 40 of west shore traverse at the mouth of the Waterton River. This point was carefully cross-sectioned for a dam site with a view to increasing the storage capacity of the basin of the Waterton lakes. The basin at present forms a magnificent reservoir in its natural state and receives the flow of numerous surface creeks and springs in addition to the underground supply of the lakes.

Line levels were taken in this district along the east and west boundaries of Township 2, Range 28, and west boundary of Township 3, Range 28, west of 4th meridian.

No gauging was taken of the river or creeks owing to the failure of the electric battery for the meter.

CYPRESS HILLS.

In accordance with your instructions, received at Waterton lakes on June 20th, I started by trail on 21st June, and travelling via Maclead, Lethbridge, Dunmore, and Irvine.

reached Elkwater Lake near Josephsburg, on 30th June ; total distance travelled on trail being about 220 miles. Commencing at the north-east corner of Township 8, Range 3, west of 4th meridian (B. M. 142), the country is rough, broken rolling prairie ; it rises to a point about one and three quarter miles south of B. M. 142, where the basin of Elkwater Lake is encountered. This lake extends two or three miles west of the line ; the basin has great capacity for storage of water and is the source of Ross Creek.

After crossing the east end of basin, the line ascends to the crest of a well defined ridge, which is heavily timbered with spruce up to 2 feet in diameter, small fir up to 9 inches, cottonwood, poplar and willow brush. B. M. 260, was established at a well defined point on this ridge visible from the north, but not from the south. On the 4th mile (east boundary of section 13), the line crosses a deep heavily timbered basin around which a detour was made. From the south edge of this basin, (about ten chains north of section 12), the country is open fairly level prairie for the next mile (east boundary of section 12), the height of land being in this mile. The country falls rapidly southerly from north boundary of Section 1, Township 8, Range 3, to Medicine Coulée, Section 25, Township 5, Range 3, a distance of about 15 miles, (height of land to Medicine Coulée), the total fall being 1,354 feet, or at the rate of 90·3 feet per mile.

The last timber visible from this meridian is about one mile east of the north-east corner of Township 7, Range 3.

From this point for 18 miles south no timber is to be seen.

From the north-east corner of Township 6, Range 3, the country south, along the line, is intersected with deep, broad coulées, all draining to Medicine Coulée, which is intersected by the east boundary of Township 5, Range 3. These coulées are normally dry, but contained a little rain water in pools when we crossed in the early part of July.

The banks are composed of (1st) loose, stony, clay soil, and (2nd), sticky clay loam ; the latter class of soil contains gypsum in fragments.

Cactus and sage brush are the most thriving growths in this portion of the country ; the grass is good, but scanty, owing to the stony nature of the ground.

Willow Creek, intersected by the east boundary of Section 13, Township 7, Range 3, is a small stream averaging at the line six to eight feet in width, and about eight inches in depth ; it joins the Medicine Coulée west of the meridian, and is incorporated at our intersection with Medicine Creek in Township 5, Range 3. After its junction the creek winds, flowing south-east down a broad valley half a mile wide. It averaged on the 10th July, about 18 feet in width and one foot in depth. As in the Frenchman Creek there are several broad deep portions, where the current is barely perceptible. The bed is generally gravelly, with soft clay places occasionally. This creek was not flowing in September, but contained water in pools.

Medicine Creek was undoubtedly above its natural flow on the 10th to 13th July, as the water was very muddy, owing to the recent heavy rains and numerous thunderstorms. Unfortunately, although all Saturday afternoon was employed, the electric Lallié meter could not be made to work, so that no gauging of this stream is on record, until crossed by the base line.

The character of the Medicine Valley from the meridian easterly, is a broad, irregular formation, banks steep to gradual, being cut-banks in some places and grassy slopes in others. The soil is very light sandy gravel with bare rocky patches in places.

Creek banks average, in middle of valley, four to ten feet, being chiefly cut-banks. Willow bush abounds along the creek. The grass is poor. Where the creek swings into the valley side, the bank is twenty to fifty feet high.

The country rises south along the meridian between ranges 2 and 3, up to B. M. 262, (22 chains south of north-east corner of Section 13, Township 5, Range 3, west of 4th meridian), when the height of land is reached, and then falls to the south. The creek flows easterly until it winds around this height of land, when it flows southerly into Milk River.

Medicine Creek (or Medicine Lodge Coulée) is known by some people as Willow Creek, after the junction of Medicine Coulée with Willow Creek for instance, at the point mentioned above. The character of the country traversed by the meridian south of B. M. 262, is rolling open prairie, inclined to be hilly ; north of B. M. 262, for nine to ten miles the country along the meridian is one succession of deep dry coulées

The soil throughout this district is of a very light and sandy character; the grass is of good quality, but grows sparsely on the uplands.

There is no timber of any description, beyond that already mentioned, in this district. Willow brush grows along the creeks.

Turning east at the north-east corner of Township 4, Range 3, west of 4th meridian, the country continues open rolling prairie draining southerly. Medicine Creek is again intersected by the north boundary of Section 36, Township 4, Range 2, west of 4th meridian, and at a point 40 chains up stream from this crossing, a gauging was taken with the small electric meter, also a cross-section. This creek ceases to flow every summer, water remaining in pools. The same applies to Middle Fork Creek, south of Ten Mile. Between Medicine Creek to Middle Fork Creek (Section 5, Township 5, Range 29, west of 3rd meridian) there is some very rough prairie, consisting of numberless cone shaped grassy hills; otherwise, rolling prairie is met with. Middle Fork Creek is said to be a a branch of Battle Creek. No gauging was taken, as the flow was entirely confined to a stream three inches in depth, between the pools.

The valley of Middle Fork Creek is a succession of gravelly clay cut-banks with grassy slopes here and there. The creek bed is gravelly and solid. The valley bottom averages ten to fifteen chains in width. A good deal of alkali is seen in the banks &c. From Middle Fork Creek to Battle Creek (Section 2, Township 5, Range 27, west 3rd meridian) east along the base line, rolling open prairie is met with, and no topographical features are apparent.

The soil is very light and sandy, the grass very thin, Battle Creek is a clear slowly running stream with good clayey banks; its fall in a measured mile was only 3.5 feet. A cross-section and gauging was taken of this creek, 8·35 chains down stream from intersection of the base line.

From Battle creek to the north east corner of Township 4, Range 26, west of 3rd meridian, the point at which line levels turn north, the country is gently rolling prairie with a few sloughs containing water, on the date we crossed in July. The soil is light and sandy, the grass thin and scanty. From the north-east corner of Township 4, Range 26, west of 3rd meridian, going north on the meridian between ranges 25 and 26, the country rises through similar prairie for eight miles (north-east corner Section 12, Township 6, Range 26). From this point many coulées occur, all draining to Cypress Lake, or Belanger Creek. After crossing the valley of Cypress Lake the line intersects Belanger Creek, of which a cross section and gauging was taken.

This creek is small and clear, averaging about seven feet in width and six inches in depth where a good flow occurs. However, it is on the average deeper (about 1.5 ft.), between vertical banks with a very sluggish flow. Willow brush and a little dry timber in places is found along the valley of the creek. The grass is good, soil being sandy loam.

CYPRESS LAKE.

This lake receives the flow of two creeks, viz.: Oxarart Creek from the west and Sucker Creek from the east, There is a height of land between the lake (at the east end) and Belanger Creek, the valley of the lake being continuous with the valley of Belanger Creek. The bed of the valley rises (going east) to a point 18 feet above the present water level of Cypress Lake at the east end. The valley bed then falls easterly to Belanger Creek. The height of land is situatad on Section 24, Township 6, Range 26, west of 3rd meridian.

On the west slope of the height of land, Sucker Creek, coming into the valley from the north, flows to Cypress Lake; on the east slope a dry channel, shown on maps as head of Frenchman Creek, falls to Belanger Creek. The water in Cypress Lake has receded at least one mile from east to west at the east end, in the last six years. Hay is now being cut where the water of the lake used to lie. The water stored in the lake could only be diverted to the south.

DIVERSION OF BATTLE CREEK INTO CYPRESS LAKE.

This scheme is perfectly feasible and can be accomplished at small expense owing to the peculiar topographical formation of the country. It seems quite possible that Battle Creek has at one time flowed easterly into Oxarart Creek and thence into Cypress Lake, instead of turning sharply to the south as at present.

The valley of Battle Creek in Township 6, Range 27, west of 3rd meridian, continues easterly to Belanger Creek, in Township 6, Range 25, west 3rd meridian, by way of Oxarart Creek and Cypress Lake. There is, of course, a height of land across this valley, which occurs between the junction of Cottonwood Coulée, with Battle Creek and Oxarart Creek, or at a point near the centre (east to west), of Township 6, Range 27, west of 3rd meridian. The difference between the water level of Battle Creek at elbow where it turns south, and the lowest point on height of land is about thirty feet. Levels were therefore taken up stream for three miles, the result being the location of a point sufficiently high to allow of a canal or ditch being taken out and graded down the valley, across the height of land, to a junction with Oxarart Creek, and consequently with Cypress Lake. The length of the proposed canal would not exceed four miles at the utmost. A compass traverse was made of this line.

DAM SITE EAST END OF CYPRESS LAKE.

As already mentioned, the valley at east end of Cypress Lake rises to a height of land about eighteen feet above present water level, it is therefore apparent that the water can be raised at least fifteen feet without any artificial dam being constructed. However, a cross section of the valley has been taken at water line of lake (east end), and also at height of land, so that the cost of a dam can be calculated.

Cross sections were also taken between the elbow of Battle Creek and Oxarart Creek (west end of lake).

Belanger Creek could be easily diverted into Cypress Lake, being 24 feet above lake bed at a point one mile north on the meridian. The valley running through from Battle Creek to Belanger Creek (Township 6, Ranges 25, 26 and 27 west of 3rd meridian), has grassy sloping banks for the most part, and averages 30 to 60 chains in width, except where the lake is met with; here, it has a wider basin. The soil is sandy loam and the grass good and luxuriant. The filling of Cypress Lake would submerge a great deal of hay land now being used by settlers. Along Battle Creek there are cut-banks, with grassy slopes alternating. There is no timber to speak of in the above mentioned district.

From the intersection of Belanger Creek, Section 25, Township 6, Range 26 west of 3rd meridian, the chainmen found no corners marked by mounds or posts until the township corner was reached. As this one and one-half miles of line is exceedingly rough and cut up with coulées, a detour was made with the levels up the valley of Belanger Creek to the township corner, at which point our work turned east along the correction line, north-east corner of Township 6, Range 26. Owing to the fact that the north side of the correction line alone was surveyed, the line levels were taken on that side of the road. The levels on this portion of the line traverse bench land with light rocky soil, and thin grass crop.

Turning north once more, at south-east corner of Township 7, Range 25, the country rises steadily for the next six miles to the north-east corner of Township 7, Range 25. The grass improves on this six miles, and a large herd of cattle range in the vicinity. All the coulées (generally dry), drain south-east to Fairwell Creek.

Turning east from the north-east corner of Township 7, Range 25, levels were run for twelve miles; B. M. No. 269, being planted at the easternmost point reached, north-east corner Township 7, Range 23. Two well defined valleys, east and west forks of Fairwell Creek, are intersected in Range 24, but in neither case was flowing water found in the creek channels, when crossed by our party in the latter part of July.

A compass traverse was made on the east branch, southerly to the forks, but the channel was found to be quite dry at this point also. The electric meter was taken

along but to no effect. The line after leaving east branch of creek in Range 24, ascends to the bench, and the six miles across Range 23 is one endless succession of coulées, all dry, draining south and south-east. The soil is light and very stony, the grass very scanty. There are no noteworthy topographical features. Antelope are plentiful in this district.

Returning to the north-east corner of Township 7, Range 25, and levelling west, Davis Creek is intersected on Section 34, no flow at time of our crossing, and very insignificant channel; the only place where flow was encountered on this creek was near the mouth, in Township 6, Range 25. Evidently the source of supply to Davis Creek consists of surface water in the spring time, and local streams scattered along its channel.

The main channel of Belanger Creek is intersected by the north boundary of Section 36, Township 7, Range 26, and not as shown on map.

Belanger Creek is a small spring creek with a good flow at the above mentioned point; it is fed by numerous springs which all rise on the southern or Milk River water-shed.

These springs are scattered along the creek from the source southerly, and therefore any diversion at the source cannot materially affect the flow farther south. An investigation was made of the existing diversion from Belanger Creek into Maple Creek, and it appears that these creeks are only ten chains apart at the centre of Section 21, Township 8, Range 26, west of 3rd meridian. After crossing Belanger Creek valley in Section 36, Township 7, Range 26, and travelling west, the line ascends to the summit of a large plateau, very much broken by coulées and hills and forming part of the Cypress range. The north boundary of Township 7, Range 27, west of 3rd meridian, crosses this plateau entirely on the southern slope or Milk River watershed. The plateau rises to the east as well as the north up to a point 22 chains east of the north-east corner of Section 34, Township 7, Range 27, where B. M. No. 271, was established (elevation 4126·49). This point is the east edge and top of escarpment of the plateau; a drop of 330 feet takes place here, into a dry valley, draining south. From the bed of this valley, we again ascend 130 feet, and thence the line traverses a broken, rolling, hilly prairie country, falling west and south towards Oxarart Creek valley, which turns easterly at the north-east corner of Township 7, Range 28.

A fine spring creek is intersected by the north boundary of Section 32, Township 7, Range 27, at 12·70 chains going west from north-east corner. The source of the spring is about six chains north of intersection. This creek flows south-east into Oxarart Creek. The north-east corner of Township 7, Range 28, brings the levels to Oxarart Creek valley. A dry channel comes in from the east and turns north into the lake in the valley. This channel is crossed four times by the north boundary of Section 31, Township 7, Range 27, and contained water at the first two crossings on August the 9th. There is no flow along valley at the township corner, but a large grassy lake of standing water exists here. This lake lies in the height of land between watersheds. The valley is continuous through the hills, and falls north about two miles north of the line crossing the north boundary of Township 7, Ranges 27 and 28. It would appear, however, that the overflow from high water goes from the south end of the lake into Oxarart Creek, and thus on into Cypress Lake. The basin averages 25 to 35 chains in width, is from one and one-half to two miles long, and shallow.

A portion of the water lying in this height of land can undoubtedly be diverted into Fish Creek, which flows northerly, but the supply appears to be limited and probably would not flow in the channel of Fish Creek for more than three or four miles before disappearing underground. The diversion of Belanger Creek into Maple Creek warrants this assumption. From Oxarart Creek valley the country rises steadily for four miles and 57·75 chains west, when the east edge of a large valley, known as Six Mile Coulée is encountered. This valley empties into Battle Creek, in Township 6, Range 29.

At the intersection of the line levels (north boundary of Section 31, Townshp 7 Range 28) the valley bottom is chiefly muskeg. A spring creek flows southerly through muskeg, but disappears before reaching Battle Creek. Continuing west, the line levels traverse a high plateau draining south to Battle Creek. Deep coulées are inter-

sected by the line (north boundary of Township 7, Range 29), heavily timbered with spruce, cypress pine, poplar and brush.

A detour south was made with the levels, which were again connected with the line at the intersection of Battle Creek, north boundary of Section 36, Township 7, Range 30.

The north fork only of Battle Creek is intersected, and from this point on to north-east corner of Township 7, Range 2, west of 4th meridian, the line traverses a high plateau and separates the north and south forks. The junction of these forks occurs on Section 36, Township 7, Range 30, west of 3rd meridian.

Across Range 30, west of 3rd meridian, and Range 1, west of 4th meridian, Township 7, the line continually dips into a heavily timbered valley, making detours necessary. The timber in this valley is chiefly cypress pine, and ranges from three to twenty-four inches in diameter. A fire has killed the growth, and the valley bed is piled up with dry fallen timber, especially at the point intersected by the fourth meridian. This valley, which runs almost east and west contains springs, and a flowing creek is maintained, which forms a branch of Battle Creek.

With regard to the project of diverting water, now flowing south, to the northern watershed, it may be said, that this is impracticable for the following reasons, based on actual investigation :—All the creeks crossed by north boundary of Township 7, from the east boundary of Range 3, west of 4th meridian to the east boundary of Range 23, west of 3rd meridian, were dry at the time of line levelling except : (1) Belanger Creek ; (2) Sucker Creek, (Range 26), and (3) Battle Creek.

The three exceptions are quite insignificant at the point of crossing, north boundary of Township 7, and even if they could possibly be turned north would not be sufficient to maintain flowing water for any distance in northerly channels. Why then do they maintain a flow southerly ? Because they are fed by innumerable springs, and these springs do not apparently exist on the northern (or Saskatchewan) watershed of the Cypress Hills. From this it is obvious that by the time the creeks of the Southern or Milk River watershed are of sufficient volume to be of practical utility, the elevation is several hundred feet below that of the divide or point of proposed diversion.

North from B. M. 269, north-east corner of Township 7, Range 23, west of 3rd meridian, a very broken country is encountered for the first twelve miles, being heavily rolling prairie intersected with coulées. The land traversed drains easterly to Frenchman Creek.

At the north-east corner of Township 9, Range 23, the line levels were carried west intersecting Bear Creek, east and west forks. Both forks of this creek were flowing when crossed in September.

Owing to heavy spruce timber being encountered five miles west of the township corner, the line levels were turned north for one mile at the north-east corner of Section 35, Township 9, Range 23, and then continued west for seven miles to the east boundary of Range 25, from thence south to B. M. 154, established by Mr. Gibbon, D.L.S., in 1896. The country traversed from east to west is entirely on the northern or Saskatchewan watershed. The various creeks crossed are heavily timbered with spruce and poplar. The country is very rough and hilly, the grass good and plentiful.

South from B. M., 261, to north-east corner of Township 4, Range 2, west of 4th meridian, the country is a high plateau for the first three miles, and then drops rapidly to Medicine valley. The soil is light and sandy, and rocks abound on the surface. The grass is plentiful and good. There is no timber of any description in the district traversed by these levels.

FRENCHMAN CREEK.

The source of this creek, erroneously shown on maps as Cypress Lake, is Belanger Creek, joined by Davis and Fairwell Creeks. Cypress Lake cannot possibly be the source of any river flowing easterly, because the water in Cypress Lake is at least one mile west of the height of land, at east end of lake. This point is illustrated by Sucker Creek which crosses the north boundary of Township 6, Range 26, in Section 35, continues south-east to section 36, Township 6, Range 26, but on entering the valley of

Cypress Lake, turns west and empties into the lake. This creek is erroneously shown on map as flowing into Belanger Creek.

The Frenchman Creek is a sluggish stream, with soft muddy clay banks and bed. It was more like a chain of pools connected by a small flow, than a flowing creek in September last.

A canal from the Frenchman to Swift Current Creek is quite impracticable owing to : (1st) the small fall of the creek per mile ; (2nd) the large number of cutbanks along the creek valley, and (3rd), the topographical features of the Frenchman Creek valley, which is intersected by numberless ravines and coulées.

A transit traverse was made, with accompanying levels, from the junction of Fairwell Creek with Frenchman Creek to the nearest available point on Swift Current, a distance of twenty-six miles.

I have the honour to be sir,

Your obedient servant,

R. W. MACINTYRE, C.E.

DIVISION "A," PARTY No. 2.

O. YORK, C.E., IN CHARGE.

DEPARTMENT OF THE INTERIOR,
SURVEYS AND IRRIGATION,
CALGARY, 6th December, 1897.

J. S. DENNIS Esq., D.T.S.,
Calgary, Alta.

SIR,—In accordance with your instructions, dated the 10th of June, I proceeded to Moosejaw, and arrived there on the 14th of June, and after a few days occupied in the purchase of the necessary stores, and making repairs to wagons &c., I descended the Moosejaw valley and pitched my first camp near the creek on Section 5, Township 17, Range 25, west of the 2nd meridian, at a spot where the hills on each side of the valley approach each other, and which I judged suitable for the establishment of a dam.

The length of a dam constructed on this site will be about 750 feet, and the height will be $21\frac{1}{2}$ feet in the creek bottom. With this height of dam, the water stored up will make a reservoir about 110 chains in length, with an average breadth of ten chains. The material for the construction of the dam can be obtained from the hills on the south side of the valley, where the soil consists of a sandy loam. The fall of the creek below the site of the dam is 2·91 per mile, and the rise above the site is 2·30 feet per mile.

I left the Moosejaw valley on the 3rd of July, and arrived the same day in the Qu'Appelle valley, and made a cross section of the Qu'Appelle River at Lanyon's Crossing, Section 4, Township 19, Range 24, west of the 2nd meridian, which I had the honour to forward to you. At the crossing, the valley is about three quarters of a mile wide, and the flats on the south side of the river are overflowed during the flood season. On the north bank, the ground is above the level of the floods. The river at this spot is about thirty feet wide, and the water at the time of my visit was eighteen inches in depth, but during the flood season the water rises about sixteen feet above the bottom of the river.

I left Lanyon's Crossing on the 6th of July, and arrived in the Cottonwood valley in the evening of the same day. At this place I remained a few days in order to be able

to communicate with you, and on the 12th of July I moved up the Cottonwood valley, examining the ground as I proceeded. I found a suitable site for a dam on Section 25, Township 18, Range 22, west of the 2nd meridian. The length of the embankment will be eight chains, and its height (in the bed of the creek) will be twenty-nine feet. This height of dam will make a reservoir about 80 chains in length, and an average breadth of eight chains. Neither at this point nor in the Moosejaw Creek was I able to measure the velocity of the stream. There was in both cases little or no water running, the beds of the creeks containing only pools here and there. The fall of the Cottonwood Creek was 7·89 feet per mile below the site of the dam, and 10·38 feet above.

On the 22nd of July I proceeded still further up the Cottonwood valley, and camped near a suitable site for a dam, on Section 24, Township 17, Range 22, west of 2nd meridian. This dam will be situated on the road allowance and will serve as a bridge. The embankment will be about 490 feet in length, and the water in the reservoir will be twenty feet above the level of the bed of the creek. The reservoir will extend up two valleys, one branch running south and the other running east. The former will be 170 chains in length, and will reach to the dam constructed by the Canadian Pacific Railway Company, and the latter will have a length of about ninety chains, with an average width of three chains. The width of the arm of the reservoir running south will be about eight chains. The fall of the creek below the site of the dam is 4·09 feet per mile, and 7·17 feet per mile above the dam. The bed of the creek was dry with the exception of pools existing along its course, and the bottom boggy.

On the 30th of July, I left the valley of the Cottonwood and crossed over to the Wascana Creek. I found a site for a dam on Section 11, Township 18, Range 21, west of the 2nd meridian. The length of the embankment will be eleven chains, and height from the creek bottom twenty-four feet. This height of dam will give a reservoir about 150 chains in length with an average width of ten chains. The material for the construction of the bank will be taken from the cutbank on western side of the creek where the soil consists of a stiff loam. The fall of the creek is 6·40 feet per mile below the site of the dam, and 7·36 feet per mile above the site. There was no running water in this creek, only deep pools here and there.

I left the Wascana valley on the 9th of August and arrived at Boggy Creek the same day, and camped on Section 19, Township 18, Range 19, west of 2nd meridian.

Whilst at this place I had the honour of calling on you at Regina and submitting to you sketches of the work so far done, and after obtaining a fresh supply of stores I proceeded up the Boggy Creek and camped on Section 28, Township 18, Range 17, west of 2nd meridian. From this place I examined the creek for about six miles above the camp. I could not detect any signs of there being any running stream in the valley during the flood season, and the settlers informed me that at no time of the year was there any running water, the rain or snow collecting in pools which dried up or soaked into the ground a short time after their formation. All the water required by the inhabitants is obtained from wells, the water being met with at a depth of twelve or fourteen feet from the surface.

On the 21st of August I left this district and descended to Boggy valley, and fixed on the site for a dam on Section 28, Township 18, Range 17, west of 2nd meridian. This dam will be three chains in length and its height in the bed of the creek will be fourteen feet. This will create a reservoir fifty-six chains in length, with an average width of ten chains. No water was running in the creek at that season. The fall in the valley is 15·24 feet per mile below the site of the dam, and 7·13 feet above.

On the 27th of August I left the Boggy valley and proceeded south by way of Balgonie and Davin to the Manybone Creek and camped on Section 4, Township 14, Range 13, west of 2nd meridian. I inspected this creek for seven or eight miles south of the camp, and for about six miles to the north, and levelled along the valley for six or seven miles. These levels indicated that the flow of the creek is from north to south, the fall being 4·02 feet per mile. I made a cross section of the valley on the road allowance north of the north-west quarter of Section 23, Township 13, Range 13, west of the 2nd meridian. The embankment will be 1,009 feet in length, and of an average height of twenty-two feet. The length of the reservoir will be six and a half miles, with a mean width of twelve chains. At only one spot (near the camp) was

there any water, but the indications are strongly defined that at some period, not very remote, long ponds or lakes existed in this valley, and that the country afforded pasturage for large herds of buffalo or bisons. The trails of these animals are plainly visible, the trail always being above the old high water marks, and never below them.

On the 22nd of September I left the Manybone Creek, and next day arrived at Qu'Appelle town, where I inspected two small reservoirs which had been constructed by the local authorities.

Having received fresh instructions from you, I left Qu'Appelle and made my way to Highpound or Buffalo Lake, passing through Qu'Appelle fort where I examined a dam which had been built across the river a short distance east of the fort, a report on the condition of which I had the honour to forward to you from Calgary on the 4th of November.

I arrived at Highpound Lake on the 1st of October and made a cross section of the Qu'Appelle valley at a point a short distance from the eastern extremity of the lake. A dam constructed on this site will be about three quarters of a mile in length, with a mean height of seven feet, and will raise the water in the lake four feet above its present level.

Having completed the work which you did me the honour to assign to me, I left Highpound Lake on the 6th of October, handed over the horses, wagons, tents, &c., to Mr. Riddell, and arrived in Calgary on the 9th of October.

I have the honour to be, sir,

Your obedient servant,

O. YORK, C.E.

DIVISION B.

REPORT OF ARTHUR O. WHEELER, D.L.S.

DEPARTMENT OF THE INTERIOR,
CANADIAN IRRIGATION SURVEYS,
OTTAWA, 1st of January, 1898.

To J. S. DENNIS, Esq., D.T.S., C.I.S.
In charge of Canadian Irrigation Surveys.

SIR,—I have the honour to submit the following report of the operations of Division "B" of the Irrigation Surveys for the season of 1897.

Under date the 5th of May, I was informed by the Surveyor General of Dominion Lands that the Minister had authorized the continuance of the surveys upon which I had been engaged during the past two years, and was instructed to report to you for details of the work and the composition, and equipment of my party.

I left Ottawa on the 7th of May, arrived at Calgary on the 12th of the same month, and on the 17th received from you the following instructions:

"CALGARY, 17th May, 1897.

SIR,—I have the honour to give you the following instructions for your guidance in carrying on the work of Division "B" of the Irrigation Surveys during the current season.

"Your party will be as follows:

W. J. Mackenzie, 1st assistant	$2.50	per day.
H. G. Wheeler, 2nd do	1.25	do
P. Jansen, cook	1.50	do
Thomas Smart, packer	1.25	do
Geoff. Lafferty, labourer	1.00	do
T. C. Douglas, do	1.00	do
Roy Douglas, do	1.00	do
H. L. Knowles, do	1.00	do

"Your transport will be as follows: two wagons; one double buckboard; one single buckboard; nine horses.

"Necessary pack saddles and pack outfit to fit out a pack train in the foothills and mountains where wagons cannot be used.

"The work to be undertaken by the division is a continuation of the triangulation and photographic survey of the foothills and on the eastern slopes of the Rocky Mountains, which you have been carrying on during the past two seasons.

"In effecting this work you will first complete the photographic work in the district which was partly covered last season, and will then extend the triangulation to the south, detailing a small party under the charge of your first assistant to make topographical traverses up the valleys of the streams in the district to be covered by the triangulation, so that a sketch map of the district may be prepared for use in projecting the triangulation and setting the primary stations for the same. You will continue the work which has been carried on during the past two years of locating suitable points for the creation of reservoirs on the heads of the streams heading in the area covered by your operations, and will examine these locations so as to enable you to report regarding each location; the map to accompany each report being prepared from your photographic survey of such locations.

"It is desired that you should keep such notes during the season as will enable you to report upon the destruction which has been caused to the timber, on the area covered by your work, from forest fires, and as to the causes of such fires and the best means of preventing them. It would also be well that you should note the destruction of the forest areas which is being caused by lumbering operations, particularly on the head waters of Sheep Creek and Highwood River.

"When your work is extended to the south of the area covered by last season's operations, you will make the usual gaugings of all streams, confining your work to determinations of actual discharges at date of measurement.

"So soon as you have completed the triangulation and photographic survey over such area as you consider can be properly plotted, so as to have a complete contour map of the district ready for issue by the 1st of April next, your field work will be closed up for the season, as it is not desired that you should complete more field work than can be plotted and issued in the shape of a final map by the date mentioned.

"You will report from time to time the progress of your work, and keep me advised of the location of your camp, and also of your post office address.

"I am, sir,

Your obedient servant,

J. S. DENNIS,
Chief Inspector."

The organization and equipment of the party was complete when the above instructions were received. On the 18th of May a start was made for the foothills, and on the 20th, headquarters established on the Jumpingpound Creek, at a point known as the Jumpingpound Park, distant from Calgary about 40 miles.

In accordance with your instructions, the completion of the photographic work was first taken up. The stations established in 1895 along the Jumpingpound Creek and tributaries were occupied with the camera, and new stations selected to cover the

ground, westward to the escarpment of the mountains, and northward to the Bow River. At the same time, the survey was extended sufficiently far eastward to embrace the portion of hilly country that would come within the contour interval of the final topographical map to be published.

It was originally intended to construct a map with a 100-foot contour interval, but has since been found that this interval is too wide, and that the configuration of the ground and the requirements of the survey will be better suited by a 50-foot interval.

A tie was made at the mouth of the Bow Pass with the photographic survey of the Rocky Mountains, by J. J. McArthur, D.L.S.

The secondary triangulation, and fixing camera stations were carried on, at the same time as the photographing, by my first assistant, W. J. Mackenzie, a 4-inch Troughton and Simms transit (D. L. pattern) being used for the purpose.

The photographing was attended to personally with the aid of my second assistant.

Two photographing outfits were used, stations being also occupied with the camera by Mr. Mackenzie when the opportunity offered.

During the early portion of the year smoke from local bush fires proved very troublesome, causing frequent delays.

Between the 15th and 18th June, heavy rains fell in the foothills These seemed to be the outer edge of a tremendous precipitation on the eastern slope of the mountains, for they were followed by floods of great volume and strength along all the water courses flowing eastward. Streams previously of small dimensions and sufficiently shallow to ford, almost anywhere, became raging torrents, quite impassable, carrying down large trees as though they were twigs; spreading far and wide over the country; sweeping away bridges, dams, headgates, and ditches; obliterating fords, and carving out entire new channels. The full force of the immense power let loose was felt more particularly along the courses of the larger streams, as the floods, swelled by numberless tributary torrents, rushed irresistibly towards the open plains. Many bridges were swept away, while others were left hopeless wrecks. Towns and villages were inundated in their lower levels, houses overturned, trains blocked, tracts of agricultural land left beds of gravel, and farmers and ranchers compelled to leave their homes in the bottoms and seek refuge on the higher ground.

There is no record of life being lost but many amusing incidents occurred. A certain party of prospectors from Nebraska, camping in the valley of the Elbow River, awaked at night to find their camp surrounded by the rapidly rising waters. They had only time to climb with their effects into the nearest trees when the flood swept over the spot where they had been lying. They spent the best part of two days contemplating the scenery from this exalted potition before they were enabled to gain dry land. It may be mentioned as significent of the keen insight of the noble red man, that the evening before the flood arrived their indian guide, feeling very ill, was compelled to start for the nearest village to obtain medicine. He returned much better as soon as the waters had subsided.

It is said by the old residents that there has not been so great a flood since 1884.

The effects, however, proved most benefical; for although a large amount of damage was done, and the streams continued impassible for a considerable time, yet on the other hand, exceepingly fine crops were the outcome. Throughout western Alberta pasturage was never better or more abundant; hay could be cut almost anywhere and as a rule the growth in the valleys was considered too rank, farmers and ranchers finding a more suitable quality growing on the hill slopes.

The replacing of bridges, dams, and headgates by better and more serviceable structures distributed ready cash throughout the country, which combined with the fine condition of the cattle, owing to an abundance of good feed and plenty of water, and the ready market opened up by the Crows' Nest, Kootenay and Klondyke operations, lent an impetus to an era of prosperity, already commenced, that gives promise of a great future for the cattle raising district of the North-West Territories.

At the time of the flood, the party was camped on the Jumpingpound Creek at the crossing of the Morleyville trail. This fact enabled the greatest rise of the water to be marked, and when it had subsided sufficiently, a cross-section to be made. It showed an extreme depth of nearly twelve feet at a point that at an average stage of water would not exceed five.

The computed results of the cross-sections are here given in tabular form, also a diagram (No. 7) showing the extreme flood level, the level when the cross section was made, and the water level on the 6th of the subsequent month of October when the stream was about average low water stage

The greatest rise of the stream was marked on both sides, and when the flood had subsided sufficiently to allow the necessary work to be done, a cross-section was made by taking soundings from a boat, suspended at intervals along a wire cable marked to ten feet. The average fall of the bed was obtained by levelling half a mile up and down stream from the point of cross-section. Having added the increase for the greatest rise above the level at time of cross-section to the area obtained, the discharge was computed by Kutter's formula.

CROSS-SECTION of Jumpingpound Creek.

No.	Date.	Location of cross-section.	Computed discharge.
1	June 20, 1897.	In S. E. ¼ Section 30, Tp. 24, Rge. 4 W. of 5th Mer., at a point about six chains above crossing of Morleyville trail.....	7411·24 cub. ft. per sec.

REMARKS :—Rise of bed for half mile up stream=6·79 feet. Fall of bed for half mile down stream=8·69 feet. Fall per mile=15·48 feet. Value given to *n*, (fraction factor)=·035.

In order to give some idea of the comparatively enormous body of water that, with very little warning, rushed down the bed of this stream, and similarly down the beds of all other water channels within the area of the cloud burst, the following table of measured discharge obtained in 1894 and 1895, may be given.

CROSS-SECTION of Jumpingpound Creek.

Date.	Location.	Measured discharge.	Remarks.
1894.		Cub. ft. per sec.	
June 26,....	In Sec. 6, Tp. 25, Rge. 4, W. of 5th Mer.....	85·5	Stream at mean summer stage, gauged about 2½ miles below point of cross-section, given above.
Oct. 17.....	In Sec. 3, Tp. 24, Rge. 5, W. of 5th Mer.....	24·6	Stream at low water stage, gauged about five miles up stream from cross-section given above.
1895.			
June 26.....	In N. E. ¼ Sec. 11, Tp. 24, Rge. 6, W. of 5th Mer.	133·3	Average high water stage, gauged about twelve miles up stream from cross-section, given above.

The high water measurement obtained in 1895, showed a discharge of 133·3 cubic feet per second, while the computed greatest flood discharge of last June shows 7,411·24 cubic feet per second.

The creek was forded on the evening of the 16th of June, and again on the morning of the 21st. During the interval it was unfordable. Plate I, gives some idea of the proportions reached by the flood when at its height.

In 1894, cross-sections for extreme flood discharge were taken of the beds of all streams flowing eastward from the mountains and foothill country, between the Red-deer River on the north, and the international boundary on the south. The flood level was obtained from existing indications, such as debris deposited along the borders of the streams, wash lines on cut-banks, barked trees, &c. The average slope per mile

of the bed was then ascertained by the level and the discharges calculated by Kutter's formula as above. It must be confessed that the results were somewhat astounding, and in many cases almost beyond belief.

The data obtained this spring from the Jumpingpound Creek, and later for the Highwood River, not only confirms the results obtained, but go to show that in some cases the flood discharges were under-estimated; they will moreover prove a factor well worthy of careful consideration in the future construction of dams, bridges, headgates, and other water structures.

On the 21st of June, a move was made to the Elbow River drainage basin, and on the 23rd the main camp pitched on Bragg Creek, about two miles from the junction with the Elbow. From this point, by means of flying camps, using pack horses for transport, the photographic work was completed over the country between the Elbow River and Jumpingpound Creek on the north, and Elbow River and Fish Creek on the south.

Considerable difficulty and delay was experienced in moving from station to station owing to the saturated condition of the country and the high water stage of the streams. This was particularly the case along the Elbow River, where in many places the pack-trail had been completely washed away, or blocked by fallen and stranded debris.

Heavy rains on July 2nd, 4th, 5th, 6th, and 7th, caused the still swollen Elbow to rise again, rendering the crossing of the river far too dangerous to warrant the risk to life that would be involved. It thus became necessary to cut out new trails and take the pack train over almost impassable places in order to make headway up the stream. (See Plate II).

The rainy spell was followed by hot sunny weather, causing a rapid evaporation from the soaking ground, which produced a hazy atmosphere, quite unsuited to good photographic work. Owing to the numerous delays, it was the 17th of July before the programme laid out for this section was completed.

On the 19th, camp was moved to the north branch of Fish Creek.

From the 19th to the 28th July, the field-work was carried on by Mr. Mackenzie, who obtained the views required along the north and south branches of Fish Creek, and extended the survey eastward as far as desirable, at the same time continuing the secondary triangulation, and fixing the camera stations.

On my return, I found the camp situated on Fishers Creek, a tributary of the north branch of Sheep River.

The creek was measured for discharge on the 1st of August with the following result:—

CROSS-SECTION of Fishers Creek.

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location of cross-section.	Measured discharge.
2	Aug. 1, 1897.	At a point in Township 21, Range 4, W. of 5th meridian.....	15·71 c.ft. per second

REMARKS:—Bottom uniform, stones and gravel; flow even; water dark, creek fed largely from muskeg sources; creek at average stage; evidence shows that during June floods water rose 4½ feet higher than at present, reaching back 40 feet on left side and 10 feet on right, rising against cut bank; banks light clay and gravel.

The work in the vicinity having been completed by the 2nd of August, a move was made southward to Ware Creek.

The requisite views were obtained by the evening of the 5th, and on the 6th the main camp was pitched on Highwood River.

It had been decided to make micrometer traverses of the the Highwood River and its larger branches, first carrying that up the north branch, now known as Highwood

River to the source, and thence over the divide and down the stream flowing to the Kananaskis River until a connection could be made with the Elbow River traverse of the previous season. For this purpose the party was divided, my first assistant and three others being detailed for the traverse work.

The traverse was commenced at Bench-mark No. 15, situated on Highwood River at a point 55 chains south of the north-east corner of Section 1, Township 18, Range 2, west of the 5th meridian, and continued up stream until the 14th of August, by which time, it had been carried as far as could be worked advantageously from the main camp.

Detailed instructions were now given to Mr. Mackenzie, and having been furnished with means of transport and a supply of provisions, he set out on the 16th to complete the work intrusted to him.

The traverse was conducted in accordance with the methods previously employed on Jumpingpound Creek, the Elbow and Sheep rivers and other streams that have been traversed, viz.: For direction, the transit was used as long as it could be applied advantageously; when the country became too rough and heavily timbered to enable sufficient speed to be made, the magnetic compass was substituted. Distances were measured by the micrometer, and differences of elevation obtained from aneroid barometer readings, checked by clinometer readings at the traverse stations.

On the 31st of August, additional instructions were sent to Mr. Mackenzie to proceed up Cataract Creek, a stream with a large drainage basin, joining Highwood River from the south-west, so soon as he should have completed the traverse of the north branch.

From the 9th to the 14th, the other section of the division was employed extending the camera work over the Highwood River basin, both north and south of the stream, and eastward to the open rolling country. At the same time, the secondary triangulation, and location of camera stations by transit readings was carried forward.

On the 13th, the north branch was measured for actual discharge, and at the same time the extreme limit of the June flood was marked, and a cross-section obtained of the river when at its highest stage. The results are here given, also a diagram (No. 7) of the cross section.

CROSS-SECTION of Highwood River, (north branch.)

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location.	Measured discharge.	Calculated flood discharge.	Remarks.
			Cub. ft. per sec.	Cub ft. per sec.	
	Aug. 13, 1897.	At a point in N. E. ¼, Sec. 19, Tp. 18, R. 2, W. of 5th meridian.....	466·4	11,663·7	Extreme flood level was located by the debris deposited, and by the wash on the cut bank on the left side of river.

The calculated discharge was ascertained in the same manner as for the Jumping pound Creek, viz.: by obtaining the area of the extreme flood cross-section, the slope per mile, and using Kutter's formula.

It may be mentioned that on the 9th of July, 1894, a cross-section was made of the north branch at a point in Section 1, Township 18, Range 2, about seven or eight miles below the cross-section given above, and before it had been joined by the south branch, with the following results: measured discharge 907·8 second feet; calculated flood discharge 11,408 second feet, closely corroborating the amount obtained as greatest discharge for the June flood.

The photographic and triangulation party was absent from the main camp on a flying trip, from the 16th to the 28th of August, during which time it was engaged filling gaps in the camera and transit work between the north and south branches of Sheep River, work that had been discontinued the previous season owing to the smoke from bush fires. Operations were here again delayed by smoke, but, fortunately, it was not sufficiently dense to stop the work completely.

On the 31st of August, Sullivan Creek, a tributary of Highwood River, was twice measured for discharge; once near the mouth and a second time above the irrigation ditch of Mr. H. Schmid, a rancher.

The results are embodied in the accompanying schedule.

CROSS-SECTION of Sullivan Creek.

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location of cross-section.	Measured discharge.
	1897.		Cubic feet per second.
4	Aug. 31..	At a point in S.E. ¼ Sec. 19, Tp. 18, Rge. 3, W. of 5th mer.	7·41
			Stream at average low water stage.
5	Aug. 31..	At a point in N. ½ Sec. 4, Tp. 18, Rge. 4, W. of 5th mer..	5·06

REMARKS:—No. 4, Cross-section between two small rapids; flow not very even; bottom not very uniform, gravel, stones and bed rock; water line irregular; banks carboniferous shale and gravel.

No. 5, Stream gauged above a small rapid; flow even; bottom made uniform, small stones, and gravel; banks stones and gravel with covering of alluvial loam, grown with willows.

From the 1st to the 7th of September, camera and transit work was extended southward from the south branch of Sheep River.

On the date last mentioned Mr. Mackenzie and party reported at the main camp, having completed the traverses of Highwood River and Cataract Creek.

Fresh instructions were immediately drawn up and handed to him for the traverse of Pekisko Creek (middle branch of Highwood River), and Stimson Creek (south branch of Highwood River), and on the morning of the 9th of September he started with his party to carry out these instructions.

The first snow fell on 8th September, but did not remain long.

Between the 9th and 18th the photographic and triangulation work was extended over the Highwood River basin, northward to the drainage to Sheep River, southward to Pekisko Creek, and westward to the escarpment of the mountains.

On the 13th measurements of Highwood River and Cataract Creek were made for discharge, close to their point of exit from the mountains, with the following results:—

CROSS-SECTION of Cataract Creek.

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location of cross-section.	Measured discharge.
	1897.		Cubic feet per second.
6	Sept. 13..	At a point about 10 chains from its junction with Highwood River.....	57·33

REMARKS;—Water dark, would appear to be fed largely from muskeg sources; cross-section good; bottom uniform, stone and gravel; flow even; banks fairly regular, left bank alluvial deposit mixed sand and light clay; right bank ditto, overlaid with stones, boulders and gravel, both overgrown by willow brush and small cottonwood.

CROSS-SECTION of Highwood River.

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location of cross-section.	Measured discharge.
	1897.		Cubic feet per second.
7	Sept. 13..	At a point in the S. E. ¼ Sec. 35, Tp. 16, Rge. 5, W. of 5th Mer. (near W. boundary)..	109·05

REMARKS:—Clear limpid water; cross-section good for stream of so high grade; bottom fairly uniform, stones and gravel, some large stones and some small boulders near either water line; flow fairly even; water line as regular as found in streams of this description; banks on left side gravel, on right side gravel stones, boulders and sand, rising back steeply.

On the 18th of September, Flat Creek, a tributary of Highwood River from the north was gauged with results as following:—

CROSS-SECTION of Flat Creek.

Meter No. 25. Observer: A. O. Wheeler.

No.	Date.	Location of cross-section.	Measured discharge.
	1897.		Cubic feet per second
8	Sept. 18..	At a point in N. E. ¼ Sec. 36, Tp. 17, Rge. 4, W. of 5th Mer. (near S. boundary)	32·24

REMARKS:—A mountain stream of considerable volume; Cross-section at a point between two rapids; flow fairly even; bottom fairly uniform, small stones and gravel with an outcrop of sandstone near left side; water line regular on right side, irregular on left side; banks sandstone strata tilted nearly vertical, with shale deposit below left bank.

On the same day main camp was moved east to a point on Highwood River, where it had been decided to measure a triangulation base on the flat lying immediately above the bed of the stream.

Work in connection with the base occupied the party almost exclusively until field operations were closed down for the season.

The base obtained was a little over two miles in length. It was measured carefully by a 100 meter tape, checked by a sixty-six foot Chesterman steel band, but the accuracy necessary to a final measurement was not at this time applied. Levels were taken between the extreme points for the purpose of obtaining a profile, from which to select grades for a final measurement.

The ends of the base were then connected by a system of triangles with the primary triangles already established, the base tied on to a corner post of the lands survey system, and azimuth observations taken at one end. The angular work is this connection was done with the four-inch transit, and was for the purpose of enabling a well conditioned system of expansion from the base to be selected, so that no time would be lost during the next season in reading with accuracy the angles of the triangles chosen. The observations for azimuth were made with a seven-inch transit theodolite reading to ten seconds.

On the 21st of September levels were taken at the first cross-section of Highwood River, made 13th August, to obtain the slope of the bed and enable the greatest discharge during the June floods to be approximately calculated.

Mr. Mackenzie and party reported at the main camp on the 30th of September, having completed the work intrusted to him.

On the 2nd of October the division started for Calgary, in accordance with your instructions to close operations at the end of September.

The outfits were stored and the majority of the party paid off on the 4th.

During the 5th and 6th with two members of the party, I was engaged taking levels for slope at the Jumpingpound cross-section made while the June floods were in progress.

The flood cross-section of both the Highwood River and Jumpingpound Creek have been previously referred to and the results given in tabular form. It has been stated that the results obtained during the past season bear out the results of the 1894 observations for flood discharge. They show moreover, that the 1894 results are those of extreme flood discharge, and that the flood levels then defined were in all probability defined from débris deposited and other marks created by the floods of 1884, during which year a flood, said to be greater than that of last June, occurred.

Mr. Mackenzie has reported fully to me upon the nature, methods and results of his exploratory traverse of the Highwood River and its tributaries. His report is now submitted.

The following is a summary of the work of both parties for the season:—

PHOTOGRAPHY AND TRIANGULATION.

Number of stations occupied for secondary angles	41
" stations occupied for preliminary base expansion	7
" camera stations occupied	162
" photographic views taken for map construction	530

TRAVERSE.

Number of miles of micrometer traverse	124
" miles of pace traverse	17
" traverse stations occupied with transit	234
" traverse stations occupied with compass	153
" observations for azimuth on traverse	5
" reservoir sites located	3

Barometric work necessary to carry elevation from bench marks Nos. 15 and 17 along stream traversed.

In your instructions you state that it is desired that such notes should be kept as will enable a report to be made upon the destruction which has been caused to the timber, on the area covered by the work of the division, from forest fires, and as to the causes of such fires and the best means of preventing them. That it should also be noted what destruction of the forest area is being caused by lumbering operations, particularly upon the head waters of Sheep Creek and Highwood River.

In the above connection, I may say, that as the 1896 report of the operations of Division "B" was not submitted until the 27th of July last, the matter of timber distribution and destruction by fire was briefly dealt with in that report. It is not now intended to refer to it further than to state that for each view taken with the camera complete notes are entered of the timber embraced in that view, so that, when the final topographical maps are drawn, data will be at hand to produce a reliable timber map, that will show accurately the general distribution and the areas denuded by fire, and those over which a second growth is now spreading.

I have the honour to be, Sir,

Your obedient servant,

ARTHUR O. WHEELER,
Mem. American Society Irrigation Engineers, in charge,
Division B Canadian Irrigation Surveys.

SESSIONAL PAPER No. 13

W. J. MACKENZIE'S REPORT.

CALGARY, Alta., 20th November, 1897.

ARTHUR O. WHEELER, Esq., D.L.S.,
In charge Division B,
Canadian Irrigation Surveys.

SIR,—In accordance with your instructions given me on 6th August, 1897, *re* traverse of Highwood River, I took up the work already commenced by you, being at a point on the north bank of the river in Sec. 11, Tp. 18, R. 2, west of 5th Mer., and carried the traverse on from there to its source. The instruments employed were the transit, micrometer, aneroid barometer, and clinometer up to and beyond the escarpment of the east slope of the Rocky Mountains to the lower end of a high rough cañon, where I thought it advisable to discontinue the use of the transit and substitute the compass, with which instrument and the before mentioned ones the traverse was carried to the source of the stream, being at the height of land between it and the Kananaskis River. From this point, I carried the traverse along the west slope of Mount Rae and down the Kananaskis River about three miles, to tie in with our traverse of the Elbow River of 1896, the Elbow heading in a small lake at a height of land about three-quarters of a mile east of the Kananaskis River, and 700 feet above it.

TRAVERSE OF THE UPPER PART OF HIGHWOOD RIVER.

The traverse of the upper part of Highwood River was commenced on 7th August, 1897, at the quarter section corner on the east boundary of section 1, Tp. 18, Rge. 2, west of 5th M., and carried up to its source in the Misty range of the Rocky Mountains; and at the height of land between it and the Kananaskis River.

At the point where the traverse was commenced, and for some distance west and south the land has been subdivided, but it was considered advisable that the stream should be more accurately located as the photo-topographic work would extend nearly to this point of commencement.

The stream here, and for a number of miles above, flows swiftly between high cut-banks and steep side-hills, generally with terraced prairie benches sloping to the high banks and sometimes extending down to the river's edge; average width of stream 1 to 1·50 chains; average width of bed, 1 to 3 chains. The water flows over a bed of gravel and boulders, and in some places the bare rock bottom shows for long stretches. The cut-banks are usually a shaley clay, and in some cases, the sandstone rock, at a strata dip of about 60°; the stream, at these places, generally narrowing up to small falls and rapids and deep pools.

The banks from commencement of traverse are of a height of from 40 to 150 feet up to the S. W. ¼ Sec. 24, Tp. 17, Rge. 4, west of 5th M., at which point they commence to have no settled character, cut-banks being formed at the crossing of the ridges, which occur at regular intervals; between these ridges, the banks are almost level with the stream, or benches of about twenty-five to thirty feet above the water, this condition extending up to the limestone escarpment of the Highwood range of mountains.

On each side of the stream there are large areas of flat and terraced prairie benches up to Section 24, Township 17, Range 4, west of 5th meridian, when ridges extending to the stream are met with, and the country is more broken.

Coming up the stream, the first tributary of any extent is Ings Creek, joining with the main stream in S.W. ¼ Sec. 34, Tp. 18, Rge. 3, west of 5th M., and having its source in a height of land in the hills to the north-west. It is a stream of small volume, but could be used for irrigating part of the upper flats. The next stream is Sullivan Creek, meeting the main stream in S.W. ¼ Sec. 20, Tp. 18, Rge. 4, west of 5th M. This creek has its head at the west side of the hill known as "Whaleback" and flows down the fine valley of the ranches of Schmid, and Sullivan to its meeting with the

main stream. Continuing up stream, a fine creek is met with in the N.W. $\frac{1}{4}$ of Sec 36, Tp. 17, Rge. 4, west of 5th M., and which is locally known as "Flat Creek." It has its origin on the north-easterly slopes of Highwood Range, some four miles above Mount Head, and is increased by small muskeg fed creeks flowing from between the foothill ridges, and also from springs along the north slope of the hills through which it passes near its mouth. It seems to have a good steady flow and is evidently snow fed. For a distance of about four miles up this creek, the banks are low and form a bed of about three to four chains, the stream being from one-quarter to one half a chain wide. On each side the land is grassy prairie rising to low ridges with scrub, poplar and willows; the top of these ridges have a succession of small lakes, which evidently make the spring rivulets before referred to. The stream bed has a fringe of large cottonwood and spruce trees for some distance up from its mouth, though for about thirty chains up it forms a rock gorge through which the water falls at high speed to join the main stream. From Flat Creek upwards, the country begins to assume a rougher aspect, more trees being noticed, and the hills becoming more rocky, till the valley of the stream narrows down to the high sandstone ridges immediately preceding the entrance into the Highwood Range, at the foot ofMount Head.

At this point the valley of the stream, which up to here had been lined with cottonwood and scattered spruce, begins to be filled up with spruce and bunches of cottonwood and poplar, while the side-hills show patches of good spruce, a few pine, and a few fine large Douglas fir.

Just at the junction of the sandstone and limestone, Section 35, Township 16, Range 5, west of 5th M., a fine stream comes in, known as the Cataract branch of Highwood River (Dr. G. M. Dawson), but locally known as Manns Creek. This stream, at the time of survey, was discharging about one-third the volume of the main stream, (see measurement of discharge). It is admirably named, as it is a succession of falls and rapids through a deep rock gorge cut out of the limestone, which extends for about five miles up from the mouth to where it enters the west edge of the Highwood Range. At this point there is a 40-foot fall broken into two descents. From the mouth, for about three miles up, there is a disused wagon trail to Mann's tie camp, after which travel is impossible owing to the thick spruce and jack-pine and fallen timber, which is met with on the hills on each side, reaching down to the cañon through which it runs.

From the falls mentioned above, the valley of Cataract branch widens out and extends up for about four miles, bounded on each side by high sandstone hills thickly covered with spruce and jack-pine, of not much merchantable value, till it closes in at a sharp bend the stream takes from north to east where the valley forms a sort of cañon and continues as such up to the source of the stream, being in a height of land between it and the north west branch of the Livingstone River, and evidently getting its water from the snow in the crevasses and ledges up the high peaks of the Highrock Range to the west of the height of land.

About one and a half miles before the stream reaches the fall above mentioned, a dry stream bed comes in, which drains the west slope of the Highwood Range from Cataract branch south, to the height of land and source of the middle fork of Highwood River, where it takes its head. It is called "Salter Creek," and is full of water in the spring. There is an Indian pack trail down this valley from the middle fork, extending through to the head of Cataract branch.

Half a mile above Salter Creek, a stream comes in from the south west which is about half the volume of Cataract branch below the junction; it takes its head at the same height of land as the main stream, flowing down through a narrow valley, between two high sandstone ridges.

The timber on Cataract branch and its tributaries is principally spruce and jack-pine, down near the mouth the timber of both kinds being of marketable value. Surrounding Mann's tie camp, the spruce has been thinned out, but all pine is standing. Further back, the trees get much smaller, and the hills for the most part are covered with scrub jack-pine. From the pass through the Highwood Range for some eight miles up the stream the valley opens out to large flats with wooded sandstone ridges, at intervals, coming down to the stream, (see Plate III). From now on, there is no more

limestone met with, the hills on each side of the river, being in all cases sandstone, and heavily wooded with spruce, and further up, with occasional patches of jack-pine.

Two creeks come in from the south, and one from the north, the two former having their head in the high peaks of the Highrock Range, and flowing down the valley in the sandstone; the latter heading at the back of Mount Head in the Highwood Range.

In Section 10, Township 17, Range 6, west of the 5th meridian, the valley narrows down to a deep cañon, with banks ranging in height from 100 to 300 feet, for the most part being sheer rock with occasional steep banks thickly wooded. This cañon exists for about four miles, when the cutbanks discontinue, the hills on each side sloping down to the river, small flats thickly covered with spruce occurring here and there.

The stream keeps the same general character, running over a gravel bed with the rock showing at times, the width being from thirty to fifty links, and the banks averaging ten feet.

From the upper end of the cañon, up stream, to Mist Creek, four creeks come in from the north, averaging about six cubic feet per second, and draining the south west slope of the Highwood Range. Two more creeks come in from the south, from the Highrock Range. There are, also, little creeks draining small muskegs and soft places on the flats and side-hills on each side of the stream, the moisture seeming to be held on these hills by the dense forest of spruce.

At Mist Creek the stream forks, being called respectively Storm and Mist Creeks. Going up Mist Creek for about fifteen chains, a high rough cañon is met with, in some places the banks rising 500 feet of sheer rock. It is a regular mountain torrent, and the cañon continues right up to the north east base of Mist Mountain, at the south end of the Misty Range. It is snow fed, draining Mist Mountain, a part of Misty Range and part of Highwood Range. It is about one-third the volume of the main stream below the junction.

Continuing up Storm Creek the character of the stream changes to that of a mountain torrent, with big bunches of drift wood and successions of small rapids.

The hills close in, and here and there, a small cañon is met with; the timber continues very heavy, some very large spruce being met with in small flats.

A succession of small creeks come in from both sides, in some cases direct from the snow patches on the Elk Mountains and Misty Range, and in others fed from springs on the sandstone side-hills, evidently seepage which is retained by the lack of means of evaporation due to the timber.

The condition, above described, continues till the summit is approached, when the limestone range narrows, and finally, the stream is seen coming down from a large amphitheatre in the Misty Range, having in it deposits of snow and ice, the stream breaking up into five small heads. There is also another small stream which heads in the same range immediately at the height of land between it and the Kananaskis, that assists in forming the source of Storm Creek but, while snow fed, does not amount to much.

For three miles down stream from the height of land, the timber is more scattered and on the summit only scrub, spruce, pine and tamarac are found.

The trail, from commencement of the traverse is a good wagon trail on the north side of the stream, and continues as such up to Cataract branch, when it turns up this branch.

Continuing up the main stream a fairly good pack trail exists to above the long cañon mentioned, when it is considerably broken up by the spring floods and fallen timber and drift. It improves again above Mist Creek and continues up to the summit and over to the Kananaskis Valley.

All along the river the results are seen of the enormous body of water that must have flowed down during the spring floods, bed changed, trails destroyed and trees uprooted making travel very difficult in places.

From the pass through the Highwood Range to the source of the stream the timber on the sandstone hills is remarkably heavy being, in general, spruce, with occasional patches of jack-pine. This timber has the effect of holding a great deal of moisture, and serves to keep the stream at a steady flow through the dry season. From observation,

it would be well if these spruce forests be carefully kept from depletion by fire or other causes, and so ensure a steady supply of water.

TRAVERSE OF PEKISKO CREEK (MIDDLE FORK OF HIGHWOOD RIVER).

The traverse of Pekisko Creek, was commenced on 10th September, 1897, on the north bank of the stream at a distance of 3·80 chains south from the quarter-section corner on the east boundary of Section 36, Township 17, Range 2, west of 5th meridian, and the barometric levels at B. M. 17, on the north bank of the stream, and carried up to its head behind Sentinel Mountain, in the Highwood Range of the Rocky Mountains.

At the point of commencement of the traverse, the banks of the stream are very high and steep ranging from 20 to 150 feet, and also in places, sloping down in terraced benches to the water's edge.

The water flows over a gravel and rock bed, varying from twenty to fifty links in width.

The valley of the stream is very variable, the incoming benches forming shale and clay cut-banks.

There are bunches of cottonwood trees in the river bottom, which continue with more or less regularity all the way up the stream, till the spruce appears.

The country on each side is benchy prairie land, with no trees of any description till the scrub poplar, etc., is met with up stream.

In the S. W. ¼ Section 25, Township 17, Range 2, west of 5th meridian, the south fork of Highwood River (Stimson Creek), meets Pekisko Creek, coming in through cutbanks.

In the S. W. ¼ Section 29, Township 17, Range 2, west of 5th meridian, the banks widen out, giving the stream a broad open valley ranging from forty to eighty chains, with benches on each side, this valley extending up to the S. W. ¼ of Section 34, Township 16, Range 3, west of 5th meridian, and containing the home ranges of the North-west Cattle Company, Mrs. Bedingfield and George Emerson.

The bench lands on each side of these ranches are eminently suitable for irrigation, as also are some parts of the stream bottom, though most of the flats are gravel.

The stream through Sections 1, 2 and 3, Township 17, Range 3, and Section 34, Township 16, Range 3, divides into small channels in places, and at present naturally irrigates some of the lower flats.

The banks of the stream on each side through the valley are heavily timbered with cottonwood and occasional spruce.

A small creek comes in from the north in S. W. ¼ Section 3, Township 17, Range 3, draining some extensive muskegs, and small lakes on the height of land between the north and middle forks, and discharging approximately four second feet.

In the S. W. ¼ Section 34, Township 16, Range 3, the banks close in and form what is locally known as "The Cañon," though in reality it is a valley with sharp sloping banks covered with cottonwood, poplar and spruce, with a height of from 40 to 100 feet, and an average width of eighteen chains, with a length of one and a half miles.

This valley is well filled with cottonwood, poplar and spruce trees, with thick willow on the stream banks.

After "The Cañon" is passed, the valley opens out to the south and west, (Section 28, Township 16, Range 3), and has much the same character that the country has below it, except that the hills begin to get wooded with poplar, spruce and jack-pine, and the ridges more definite, and showing more rock outcrop.

The average width of the valley is about one mile, and two ranchers are located in it, named Greig and Thorpe, both having excellent opportunities for irrigation.

In the N. E. ¼ Section 23, Township 16, Range 4, the stream breaks through a small ridge ending the valley, and forming the means of damming for reservoir purposes. The banks behind, however, are not high, the lowest point in available area are being about twenty-five feet above the stream bed, the stream having a large fall here.

It is not an eminently suitable reservoir site, but could be used to advantage if the necessity arose.

There are excellent opportunities for procuring timber, and the stone in the vicinity would be adaptable for building purposes.

The valley of the stream, from here up through Sections 22, 15, 14 and 11, Township 16, Range 4, is a succession of rising benches, with the stream running through a small cañon, in sections 22 and 15, a fall of ten feet occurring in N.E. ¼ Sec. 15, at the home ranch of one McConnell. Two streams come in from the west, heading in the high sandstone hills at the foot of the Highwood Range, neither of them of much note.

The ridges in the vicinity are wooded with scattered spruce and jack-pine and poplar clumps, with extensive tracts of windfall and brulé, which tracts are gradually being retimbered by a natural process.

In the S.W. ¼ of Section 11, and N.W. ¼ Section 2, Township 16, Range 4, an eminently suitable reservoir site is met with, with excellent opportunities for dam making, timber and good stone being in the immediate vicinity.

Continuing up stream, in the N.W. ¼ of Section 35, Township 15, Range 4, the stream forks, the lesser having its head in the Highwood Range to the west. Several other small creeks come in, in the vicinity, draining the adjacent hills. There are some extensive prairie benches in Sections 35 and 27, Township 15, Range 4, west of the 5th meridian, the stream itself being inclosed by high clay cut-banks.

In Section 27, Township 15, Range 4, two streams come in from the west, draining part of the Highwood Range and meeting the main stream through high cut-banks.

From here to the source of the stream, it flows through a high rock and clay cañon, formed from the high sandstone ridges on each side, and finally from the steep sides of Sentinel Mountain and the adjacent limestone cliffs of the Highwood Range, at the base of which the stream takes its source; this amphitheatre being heavily wooded in places with spruce and jack-pine; Sections 9, 16 and 17, Township 15, Range 4, west of 5th meridian, containing this source. (See Plate IV).

The traverse was carried over the divide in Section 17, down Salter Creek, an account of which is given in the report of the traverse of the north fork of Highwood River.

A good wagon trail exists along the banks of the middle fork from Pekisko, (Section 7, Township 17, Range 2, west of the 5th meridian) to Section 2, Township 16, Range 4, after which a good pack trail extends to the source of the stream, and over the divide between it and Salter Creek to the Livingstone River.

All up this stream, till within about seven miles of its source, the benches offer excellent facilities for irrigation, the land being good, and water being able to be put on it without difficulty.

TRAVERSE OF STIMSON CREEK.

The traverse of Stimson Creek was commenced at Station 4 of the traverse of Pekisko Creek, near the junction of the two streams in the west half of Section 25, Township 17, Range 2, west of the 5th meridian, and was carried up stream to its source in Section 17, Township 15, Range 4.

The stream (a small affair of an average width of twenty links with a very sluggish flow), runs in a valley about eight chains wide, bounded by clay banks of a height of about fifty feet through Sections 14, 23 and 25, Township 17, Range 2, after which the banks decrease in height, the prairie benches coming, in some cases, down to the water's edge. These banks remain low till Section 29, Township 16, Range 2, is met with, when the low ridges on each side of the stream form banks of an average height of thirty-five feet. The high banks continue, forming the valley of the creek, to the south halves of Section 16 and 17, where they run out, and in the north half of Section 8, Township 16, Range 2, a creek, locally known as Hay Creek, comes in from the west. It is about one-half the volume of the stream below the junction. Low banks are formed again, and the valley continues up till Mud Creek is met with, at north-east ¼ Section 32, Township 15, Range 2, coming in from the west and being about half the volume of the stream below the junction.

The stream from now up is a very small affair, running in a valley, between two scrub timbered ridges till, in Section 21, Township 15, Range 4, it cuts through the ridge on the west side of the valley and finds its source in the springs and muskegs in the north halves of Sections 17 and 16.

Continuing up the valley the creek leaves, some large lakes are met with on the height of land, fuller description being given at a later date when survey of them is made.

The land on each side of this stream from the mouth to the source is benchy and rolling prairie with large tracts of hay land, which, if water could be supplied, might be irrigated to great advantage.

The main trail from Pekisko to Highwood River crossing, crosses the creek in Section 14, Township 17, Range 2, and a trail is afterwards met with in Section 17, Township 16, Range 2, which continues to the source of the stream.

METHODS OF TRAVERSE OF HIGHWOOD RIVER, PEKISKO AND STIMSON CREEKS AND CATARACT BRANCH.

The instruments employed in this traverse were the transit, micrometer, barometer thermometer, clinometer and compass.

In the traverse of the river, the transit was used for angular readings up to Station 103, when owing to the excessively rough nature of the country, it was thought advisable to discontinue its use, and the compass was substituted, care being taken to ascertain the correct magnetic variation at this point by observation.

On Pekisko and Stimson Creeks the transit was used throughout.

Observations for meridian were taken on Polaris at Stations 14, 41 and 103, on the river, at Station 62 on Pekisko Creek, and at Station 7, on Stimson Creek.

The micrometer was used throughout the traverse of these streams; a base for reduction being measured at the beginning of the work, and tables made. This was also done on the completion of the work, and a table was deducted giving intermediate values between the two, the work by stations being divided into three, and distances calculated by the corresponding tables.

Barometric levels were carried on throughout the complete traverse, a stationary barometer being kept at camp, and readings taken every thirty minutes while travelling barometer was in use, the barometers used being of the aneroid type.

The starting points for barometric levels were bench mark No. 15, on the north bank of the north fork of Highwood River, and B. M. No. 17, on the north bank of Pekisko Creek.

Thermometric readings were taken at all stations, and the correction due to change in temperature was used in the reduction of the barometric levels.

The clinometer was used in all cases, the angle read being applied as a correction for micrometer measurements, and also as a check on barometric levels.

The compass was used on the north fork of the Highwood River from Station 103, of the traverse to the source of the stream, careful note being made of the magnetic variation by astronomic observation. It was also used on the traverse of Salter Creek, and the upper part of the Cataract branch of Highwood River.

The traverse of the upper part of the Cataract branch and Salter Creek, was made by prismatic compass, the distances being paced, an approximate traverse being all that was required of these streams.

I have the honour to be, sir,

Your obedient servant,

W. J. MACKENZIE.

SECTION III.

HYDROGRAPHIC RECORDS.

Discharge of Streams.

In the accompanying schedule, Willow Creek, Medicine lodge Creek, Battle Creek and Belanger Creek, are streams rising in the south slopes of the Cypress Hills and flowing southward across the International boundary. They are fed by numerous springs along their beds and in the deep ravines traversing the Cypress Hills, being further augmented in the spring by the runoff from melting snow.

It is noticeable, in this connection, that for the streams heading on the northern slopes of the Cypress Hills a constant supply is not maintained throughout the year as in the majority of cases on the south slopes, the springs being few in number and far between; consequently, the streams are chiefly dependent upon the snowfall, and many dry up early in the summer. It is especially unfortunate that this is the case, in view of the fact that the bulk of the irrigable lands lie to the north.

The measurements for discharge were taken by Mr. R. W. Macintyre in charge of Party No. 1, Division A, but owing to the meter in use having got out of order, measurements for actual velocity were not obtained.

Cross-sections for the different levels were made, and the slope of the bed per mile ascertained; the discharge has been computed by Kutter's formula. On this account the actual discharges of the schedule are not so reliable as would have been the case if actual velocity had been obtained.

From Jumpingpound Creek on, the streams enumerated in the schedule were gauged by Division B in charge of Mr. A. O. Wheeler.

The cross-sections obtained and resulting computations of extreme flood discharge for the Jumpingpound Creek and Highwood River are of great value, showing as they do the tremendous amount of water compared with the normal conditions, that may at any time during the summer, owing to the cloud bursts or continued heavy rains in, or along the face of the mountains, be hurled down their beds. The data here given will be particularly valuable when estimating the strength and extent of bridges, dams, headgates and other water structures on these streams.

The remaining creeks were measured for actual discharge only, on the dates given, with a view of obtaining some idea of the supply contributed to the main stream by their respective drainage basins.

As the extent and superficial area of each basin can be accurately defined by the methods of photographical surveying employed, valuable results will be obtainable as to the relative values of the streams as factors of supply.

Most of the gaugings were made at average low water stage.

SCHEDULE showing Measured or Calculated Discharge of certain Streams during 1897, Division A and Division B.

Name of Stream.	Point of Measurement.	Date.	Actual discharge.	Computed High Water discharge.	Computed Flood discharge.	Measured by.
Willow Creek	E. bdy. sec. 13, Tp. 7, R. 3, W. 4th Mer.	July 7	5·34	119·75	532·82	Div. A., Pt. No. 1.
Medicine-lodge Creek	40 chs. down stream from intersection of N. bdy. sec. 36, Tp. 4 R. 2 W. 4th Mer	" 13	1·63	19·83	56 10	" "
Battle Creek	Near crossing of N. bdy. of sec. 35, Tp. 4, R. 27, W. 3rd Mer.	" 19	29·37	72·55	218·59	" "
Belanger Creek	E. bdy. sec. 25, Tp. 6, R. 26, W. of 3rd Mer.	" 22	7·29	25·51	355·05	" "
Battle Creek	24 chs. down stream from N. bdy. of sec. 36, Tp. 7, R. 30, W. of 3rd Mer	Aug. 14	6·10	28·83	97·79	" "
Jumpingpound Creek	7 chs. above Morleyville trail crossing	June 20			7411·24	Division B.
Fisher Creek	In Tp. 21, R. 4, W. of 5th Mer.	Aug. 1	15·71			"
Highwood River	N. E. ¼ sec. 19, Tp. 18, R. 2, W. of 5th Mer.	" 13	466·43		11663·7	"
Sullivan Creek	S. E. ¼ 19, Tp. 18, R. 3, W. of 5th Mer	" 31	7·41			"
" "	N. ½ sec. 4, Tp. 18, R. 4 W. of 5th Mer.	" 31	5·06			"
Cataract Creek	10 chs. from junction with Highwood River	Sept. 13	57·33			"
Highwood River	S. E. ¼ sec. 35, Tp. 16, R. 5, W. of 5th Mer.	" 13	109·05			"
Flat Creek	S. W. ¼ sec. 20, Tp. 18, R. 3, W. of 5th Mer.	" 18	32·24			"

EVAPORATION.

Observations of evaporation similar to those taken in 1896, were commenced on the 1st of May, but discontinued on the 12th of June owing to the appointment of Mr. J. S. Dennis, who, up to that date, had had charge of the irrigation surveys and administration, to be Deputy Commissioner and Chief Engineer of the Public Works Department of the North-west Territories Government. Although Mr. Dennis continued to superintend irrigation matters, his new appointment necessitated his removal to Regina, and as a consequence, a disorganization of the hydrographic records for the balance of the year.

The submerged pan at the rating station and the earth pan at Mr. Dennis' shouse were both in operation for the short period above named.

Such as they are the records are submitted below, in schedule form.

OBSERVATIONS of Evaporation.—Station No. 1.

RATING STATION, CALGARY—(Pan submerged).

Date.	Gauge Readings.		Difference in Feet.		General Remarks
	At Date.	Previous.	Gain.	Loss.	
1897.					
May 1	0·0253	0·0253			Initial reading.
" 8	0·0163	0·0253		0·0090	
" 15	0·0061	0·0163		0·0102	
" 22	0·0069	0·0061	0·0008		Very windy.
" 29	0·0001	0·0069		0·0068	
June 5	0·0001	0·0001			Before refilling.
" 5	0·0377	0·0377			After refilling.
" 12	0·0466	0·0377	0·0089		Very windy.
			0·0097	0·0260	

Total evaporation to June 5th.....0·0260 ft.

OBSERVATIONS of Evaporation.—Station No. 2.

CALGARY—(Pan in ground).

Date.	Guage Readings.		Difference in Feet.		General Remarks
	At Date.	Previous.	Gain.	Loss.	
1897.					
May 1	0·0599	0·0599			
" 8	0·0549	0·0599		0·0050	Before refilling.
" 8	0·0875	0·0875			After refilling.
" 15	0·0821	0·0875		0·0054	
" 22	0·0751	0·0821		0·0070	
" 29	0·0693	0·0751		0·0058	
June 5	0·0660	0·0693		0·0033	
" 12	0·0710	0·0660	0·0050		Very windy.
			0·0050	0·0265	

Total evaporation to June 5th.....0·0265 ft.

RATING STATION.

During the winter, a requisition was made for a suitable electric clock to be used in conjunction with a chronograph, to obtain a greater degree of accuracy in rating the current meters.

The Surveyor General of the Dominion Lands, Mr. E. Deville, obtained and forwarded one of Swiss manufacture. This, together with the chronograph, was set up on a stone pier in close proximity to the rating base, and electrical connection made with the rails upon which the car carrying the meter travels, the rails being used as a part of the circuit. Attachments were then placed on the car and at ten-foot intervals along the

SCHEDULE showing Measured or Calculated Discharge of certain Streams during 1897, Division A and Division B.

Name of Stream.	Point of Measurement.	Date.	Actual discharge.	Computed High Water discharge.	Computed Flood discharge.	Measured by.
Willow Creek	E. bdy. sec. 13, Tp. 7, R. 3, W. 4th Mer.	July 7	5·34	119·75	532·82	Div. A., Pt. No. 1.
Medicine-lodge Creek	40 chs. down stream from intersection of N. bdy. sec. 36, Tp. 4 R. 2 W. 4th Mer	" 13	1·63	19·83	56 10	" "
Battle Creek	Near crossing of N. bdy. of sec. 35, Tp. 4, R. 27, W. 3rd Mer.	" 19	29·37	72·55	218·59	" "
Belanger Creek	E. bdy. sec. 25, Tp. 6, R. 26, W. of 3rd Mer.	" 22	7·29	25·51	355·05	" "
Battle Creek	24 chs. down stream from N. bdy. of sec. 36, Tp. 7, R. 30, W. of 3rd Mer	Aug. 14	6·10	28·83	97·79	" "
Jumpingpound Creek	7 chs. above Morleyville trail crossing	June 20	.....	.....	7411·24	Division B.
Fisher Creek	In Tp. 21, R. 4, W. of 5th Mer.	Aug. 1	15·71	.....	.....	"
Highwood River	N. E. ¼ sec. 19, Tp. 18, R. 2, W. of 5th Mer.	" 13	466·43	.....	11663·7	"
Sullivan Creek	S. E. ¼ 19, Tp. 18, R. 3, W. of 5th Mer	" 31	7·41	.....	.....	"
" "	N. ½ sec. 4, Tp. 18, R. 4 W. of 5th Mer.	" 31	5·06	.....	.....	"
Cataract Creek	10 chs. from junction with Highwood River	Sept. 13	57·33	.....	.....	"
Highwood River	S. E. ¼ sec. 35, Tp. 16, R. 5, W. of 5th Mer.	" 13	109·05	.....	.....	"
Flat Creek	S. W. ¼ sec. 20, Tp. 18, R. 3, W. of 5th Mer.	" 18	32·24	.....	.....	"

EVAPORATION.

Observations of evaporation similar to those taken in 1896, were commenced on the 1st of May, but discontinued on the 12th of June owing to the appointment of Mr. J. S. Dennis, who, up to that date, had had charge of the irrigation surveys and administration, to be Deputy Commissioner and Chief Engineer of the Public Works Department of the North-west Territories Government. Although Mr. Dennis continued to superintend irrigation matters, his new appointment necessitated his removal to Regina, and as a consequence, a disorganization of the hydrographic records for the balance of the year.

The submerged pan at the rating station and the earth pan at Mr. Dennis' shouse were both in operation for the short period above named.

Such as they are the records are submitted below, in schedule form.

OBSERVATIONS of Evaporation.—Station No. 1.

RATING STATION, CALGARY—(Pan submerged).

Date.	Gauge Readings.		Difference in Feet.		General Remarks
	At Date.	Previous.	Gain.	Loss.	
1897.					
May 1	0·0253	0·0253			Initial reading.
" 8	0·0163	0·0253		0·0090	
" 15	0·0061	0·0163		0·0102	
" 22	0·0069	0·0061	0·0008		Very windy.
" 29	0·0001	0·0069		0·0068	
June 5	0·0001	0·0001			Before refilling.
" 5	0·0377	0·0377			After refilling.
" 12	0·0466	0·0377	0·0089		Very windy.
			0·0097	0·0260	

Total evaporation to June 5th.....0·0260 ft.

OBSERVATIONS of Evaporation.—Station No. 2.

CALGARY—(Pan in ground).

Date.	Guage Readings.		Difference in Feet.		General Remarks
	At Date.	Previous.	Gain.	Loss.	
1897.					
May 1	0·0599	0·0599			
" 8	0·0549	0·0599		0·0050	Before refilling.
" 8	0·0875	0·0875			After refilling.
" 15	0·0821	0·0875		0·0054	
" 22	0·0751	0·0821		0·0070	
" 29	0·0693	0·0751		0·0058	
June 5	0·0660	0·0693		0·0033	
" 12	0·0710	0·0660	0·0050		Very windy.
			0·0050	0·0265	

Total evaporation to June 5th.....0·0265 ft.

RATING STATION.

During the winter, a requisition was made for a suitable electric clock to be used in conjunction with a chronograph, to obtain a greater degree of accuracy in rating the current meters.

The Surveyor General of the Dominion Lands, Mr. E. Deville, obtained and forwarded one of Swiss manufacture. This, together with the chronograph, was set up on a stone pier in close proximity to the rating base, and electrical connection made with the rails upon which the car carrying the meter travels, the rails being used as a part of the circuit. Attachments were then placed on the car and at ten-foot intervals along the

base, so that at the end of every ten feet travelled by the car, the circuit would be closed, and the instant of closing indicated on the chronograph sheet.

As no suitable means have yet been devised to propel the car uniformly at the required speeds, otherwise than by hand, it was sought to localize the irregularities in the speed while passing from end to end of the base.

The ratings obtained for Meters Nos. 24 and 25, are given below.

METER No. 24.

REDUCTION of Observations taken at Calgary, Alberta, 14th May, 1897.

BY RIGID METHOD.

R. W. MACINTYRE, *Observer.* J. G. McINTOSH, *Computer.*

No.	r	t	x	y	$x-x_o$	$y-y_o$	$(x-x_o)^2$	$(x-x_o)(y-y_o)$	Remarks.
1	26·6	21·4	1·243	4·673	+0·524	+2 230	+0·274	+1·168	
2	24·7	23 3	1·065	4·292	+0·446	+1·849	0 199	0·825	
3	25·1	19·6	1·281	5·102	+0·662	+2·659	0·438	1·760	
4	25·3	19·5	1·297	5·128	+0·678	+2·685	0·459	1·820	Length of base, 100 feet.
5	25·2	17·0	1·482	5·882	+0·863	+3·439	0·745	2·968	
6	25·2	20·0	1·260	5·000	+0·641	+2·557	0·411	1·639	
7	25·3	20·3	1·246	4·926	+0·627	+2·483	0·393	1·557	
8	24·8	34·5	0·719	2·898	+0·100	+0·455	0·010	0·04	
9	25·0	45·5	0·549	2·198	—0·070	—0·245	0·005	0·017	Meter
10	25·2	46·2	0·545	2·164	—0·074	—0·279	0·005	0·021	Vanes immersed 0·8 feet.
11	24·9	46·8	0·532	2·137	—0·087	—0·306	0·007	0·027	
12	25·2	45·4	0·555	2·203	—0·064	—0·240	0·004	0·015	
13	25·1	47·0	0·534	2·128	—0·085	—0·215	0·007	0·018	
14	25·2	85·1	0·296	1·175	—0·323	—1·268	0·104	0·409	
15	25·4	98·0	0·259	1·020	—0·360	—1·423	0·129	0·512	
16	25·6	100·3	0·255	0·997	—0·364	—1 446	0·132	0·526	
17	25·7	97·6	0·263	1·024	—0·356	—1·419	0·127	0·505	
18	25·9	100·7	0·257	0·993	—0·362	—1·450	6·131	0·525	
19	26·2	125·5	0·209	0·797	—0·410	—1·646	0·168	0·675	
20	26·4	136·2	0·194	0·734	—0·425	—1·709	0·180	0·726	
21	26·5	126·1	9·210	0·793	—0·409	—1·650	0·167	0·675	
22	26·2	126·6	0·207	0·789	—0·412	—1·654	0·170	0·681	
23	25·7	125·1	0·205	0·799	—0·414	—1·644	0·171	0·681	
24	25·8	129·6	0·199	0·772	—0·420	—1·671	0·176	0·702	
	.....	.....	14·862	58·624	.....	.....	4·612	18·497	

x_o=0·619, 2·443=y_o

NORMAL EQUATIONS.

b × 0·619 a=2·443, whence a=4·011
4·612 a=18·497 b=—0·04

EQUATION FOR RATING.

$$\text{Velocity} = 4{\cdot}011 + \frac{\text{Revolutions}}{\text{Time}} - {\cdot}04$$

METER No. 25.

REDUCTION of Observations taken at Calgary, Alberta, on May 15th, 1897.

BY RIGID METHOD.

R. W. MACINTYRE, *Observer.* J. G. McINTOSH, *Computer.*

No.	r	t	x	y	$x-x_o$	$y-y_o$	$(x-x_o)^2$	$(x-x_o)(y-y_o)$	Remarks.
1	23·4	42·9	0·545	2·331	−0·022	−0·042	+0·000	+0·001	
3	25·1	25·2	0·996	3·968	+0·429	+1·595	0·184	0·684	
4	23·6	37·2	0·634	2·688	+0·067	+0·315	0·004	0·021	
5	25·3	24·0	1·054	4·166	+0·487	+1·793	0·237	0·873	Length of base 100 feet.
6	23·4	42·4	0·552	2·358	−0·015	−0·015	0·000	0·000	
7	23·9	40·2	0·594	2·487	+0·027	+0·114	0·001	0·003	
8	22·9	43·0	0·533	2·326	−0·034	−0·047	0·001	0·002	Meter.
9	23·3	45·0	0·518	2·222	−0·049	−0·151	0·002	0·007	vanes immersed 0·8 feet.
10	23·7	20·8	1·139	4·808	+0·562	+2·425	0 316	1·363	
11	24·3	20·8	1·168	4·808	+0·601	+2·435	0·361	1·463	
12	23·9	21·3	1·122	4·695	+0·555	+2·322	0·308	1·289	
13	23·6	20·9	1·129	4·785	+0·562	+2·412	0·316	1·356	
14	24·1	20·2	1·193	4·950	+0·626	+2·577	0·392	1·513	
15	21·7	127·0	0·171	0·787	−0·396	−1·586	0·157	0·628	
16	23·0	124·0	0·185	0·806	−0·382	−1·567	0·146	0·598	
17	23·3	128·4	0·181	0·779	−0·386	−1·594	0·149	0·615	
18	23·7	123·4	0·192	0·810	−0·375	−1·563	0·141	0·586	
19	23·3	126·3	0·184	0·792	−0·383	−1·581	0·147	0·605	Observation No. 2 re-
20	23·7	91·3	0·259	1·095	−0·308	−1·278	0·012	0·394	jected.
21	23·7	85·8	0·276	1·165	−0·281	−1·208	0·079	0·339	
22	23·9	90·9	0·263	1·100	−0·304	−1·273	0·010	0·387	
23	24·0	90·6	0·265	1·104	−0·302	−1·269	0·009	0·383	
24	23·5	89·3	0·263	1·120	−0·304	−1·253	0·010	0·381	
25	23·3	123·3	0·189	0·811	−0·378	−1·562	0·143	0·590	
			13·605	56·961			3·125	14·081	

$x_o = 0·567$ $2·373 = y_o$

NORMAL EQUATIONS.

$b + 0·567a = 2·373$, whence $a = 4·506$
$3·125a = 14·081$ $b = -0·181$

EQUATION FOR RATING.

$$\text{Velocity} = 4·506 + \frac{\text{Revolutions}}{\text{Time}} - ·181$$

NILOMETERS.

As in 1896, two nilometers were in operation : one on the Langevin Bridge across the Bow River at Calgary, and the other at the Calgary Irrigation Company's flume across the Elbow River about one mile above its junction with the Bow.

Unfortunately, the records did not extend over a very lengthy period. The instrument on the Elbow River was carried away with the Irrigation Company's flume during the floods of the 17th and 18th of June, and no records were obtained beyond the week ending Saturday the 12th June.

The meter on the Bow survived the flood and recorded, to some extent, the greatest rise of water during that period, but operations were discontinued on the 26th of July, the observer, Mr. Wilson, having been transferred to the Department of Public Works at Regina.

The records obtained are shown on diagram No. 6, attached to this report. They are of great interest, in so far as the Bow River is concerned. The June floods occurred on the 17th and 18th ; on the 18th the nilometer record sheets shows a rise of two and

one-half feet. The stream undoubtedly rose considerably beyond this point, but as the range of the instrument had been reached, the additional rise is not recorded.

On the 1st May, 1896, the water level showed at 4·9 feet on the gauge rod and rose to a greatest level of eight feet near the end of July. On the 1st May 1897, the water level on the gauge rod stood at 4·6 feet and rose to the full range of the nilometer, at ten feet and beyond it, on the 18th of June, the water then fell rapidly to eight feet and again rose, touching the nine foot point on the 8th of July.

The records of these two years tend to show that highest water on the Bow, leaving abnormal conditions out of the question, occurrs sometime during the month of July.

The instruments in use were manufactured by J. S. J. Lallie, of Denver, Colorado.

The mechanism is simple, consisting of a cylinder revolved by a seven-day gearing attached to an eight-day clock, a travelling bar with teeth adapted to the scale of the record sheets, and a reduction pulley on centres. Several turns of silk bound flexible wire are taken round the pulley and one end attached to a six inch float, the other to a counterpoise. The pulley is connected with a small cog-wheel, fitted to the teeth of the travelling bar, and causing it to slide backward and forward as the float rises or falls. To the bar is attached a pencil holder containing a spring that presses the pencil point against the record sheet wound round the cylinder.

The float rests on the water inside a wooden box, perforated with several small holes, thus obtaining freedom from oscillation.

While the mechanism is simple, the construction is somewhat crude, and several weak points are apparent that might readily be remedied and render the instrument more efficient, and easy to handle.

The range of the record sheet is six feet (not sufficient). It is marked to feet and tenths, and to divisions of two hours for each day of the week.

GAUGE RODS.

Nine gauge rods were in operation during the season, five along the line of the Calgary and Edmonton Railway, and four others.

The following schedule gives the name of the stream upon which the rod was placed, the location of the rod, the name and address of the observer, the interval of the readings, whether daily or otherwise, the period over which the readings extend and the number of the diagram, accompanying this report, which shows the rise and fall of the stream.

As gauge rods were placed in connection with the nilometers on the Bow and Elbow rivers, they have been included in the schedule.

In every case, except two, the readings were taken by railway section foremen, a small monthly remuneration being paid for their service. The other two gauge rods were read by members of the North-west Mounted Police Force. Their services are due to the courtesy of the superintendents of the Police Force for the Macleod district and the western division of the Canadian Pacific Railway.

The section foremen make daily trips over the portions of the line crossing the streams where the rods have been placed, and, consequently, it is a simple matter for them to take the readings. In the case of Highwood River and Fish Creek, the foreman either passes or lives close to the points where the rod is situated.

The records for Sheep and Highwood rivers are very fragmentary, the June flood having carried away the bridges and the gauge rods with them; the remaining sheets indicate very clearly the progress and extent of the flood, and also the subsequent high water period of July.

In the accompanying diagrams, the horizontal divisions give the rise and fall in feet and fifths, and the vertical divisions show periods of two days for each month of record.

During the months of June and July, Party No. 1, of Division A placed gauge rods on the bridges at crossings of the Canadian Pacific Railway over all the principal streams draining northward from the Cypress Hills watershed, viz.: Sevenpersons,

Bullshead, Ross, MacKay, Boxelder, Fish, Maple, Piapot, and Swift Current creeks. It is intended to commence readings in this section early next spring.

SCHEDULE of Gauge Rods read during the year of 1897.

ALONG THE LINE OF THE CALGARY AND EDMONTON RAILWAY.

Name of Stream.	Location of Rod	Name of Observer.	Interval of Reading.	Period of Reading.	No. of Diagram showing rise and fall.
Nose Creek.	Railway Bridge.....	John Galbraith, sec. foreman, Calgary.	Daily.....	June, July, August, September	1
Sheep River	"	Thos. Greenwood, sec. foreman, Okotoks.	"	Part of June.	2
North Branch of Mosquito Creek.	"	Thomas Field, sec. foreman, Nanton.	"	June, July, August, September	3
South Branch of Mosquito Creek.	" ...	Thomas Field, sec. foreman, Nanton.	"	June, July, August, September	3
Willow Creek.....	"	Martin Wright, sec. foreman, Macleod..	Daily except Sunday.	June, July, August, September, October.	2

OTHER GAUGE RODS.

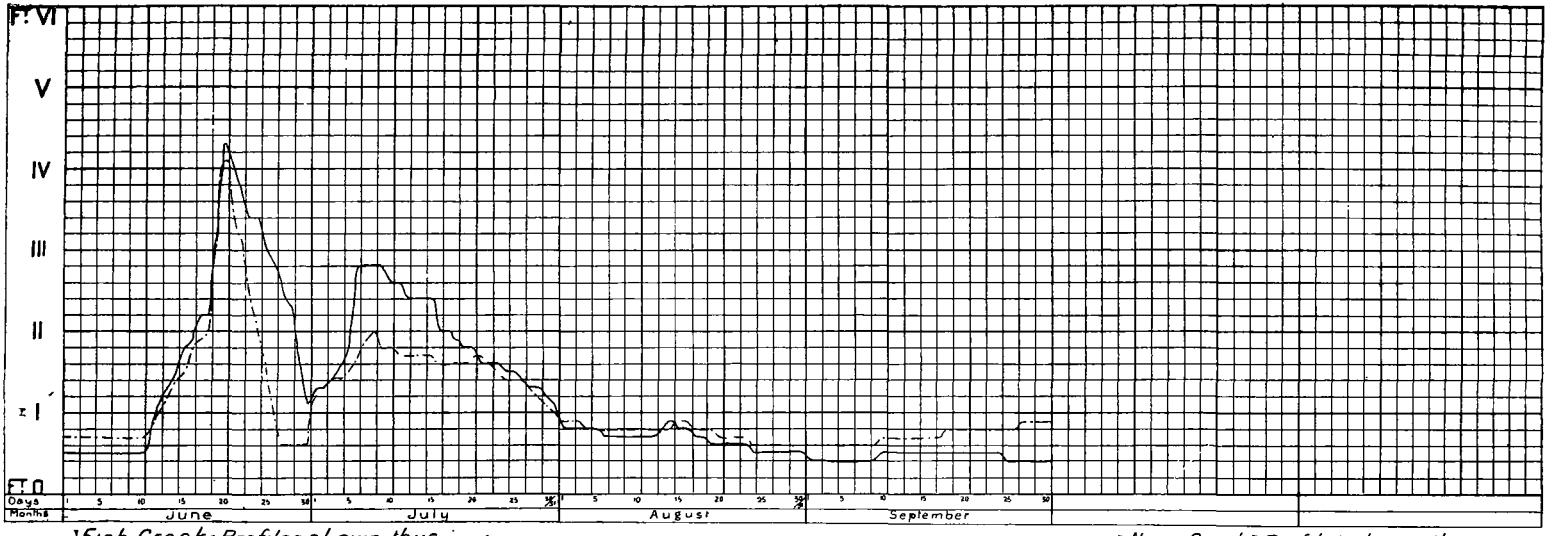
Highwood River..	Traffic Bridge, High River Village.	J. C. Bradford, sec. foreman, High Riv.	Daily.....	Part of June.	4
Fish Creek.....	Traffic Bridge, Cal. & Macleod trail.	John Galbraith, sec. foreman, Calgary.	"	June, July, August, September	1
Oldman River....	Traffic Bridge, Macleod W.	G. C. Dupré, Const. N.W.M.P.	"	May, June, July, August, September.	5
Pincher Creek...	Traffic Bridge, near Village.	P. Bertles, Sergt. N. W.M.P.	"	May, June, July, August, September.	4

NILOMETERS.

Bow River.....	Traffic Bridge.....	Chivers Wilson, Irrigation Office, Calgary.	Weekly.....	May, June, and part of July.	6
Elbow River.....	On flume Calgary Irrigation Co .		"	May and part of June.	

Diagram Showing Rise and Fall of Fish and Nose Creeks 1897

No 1

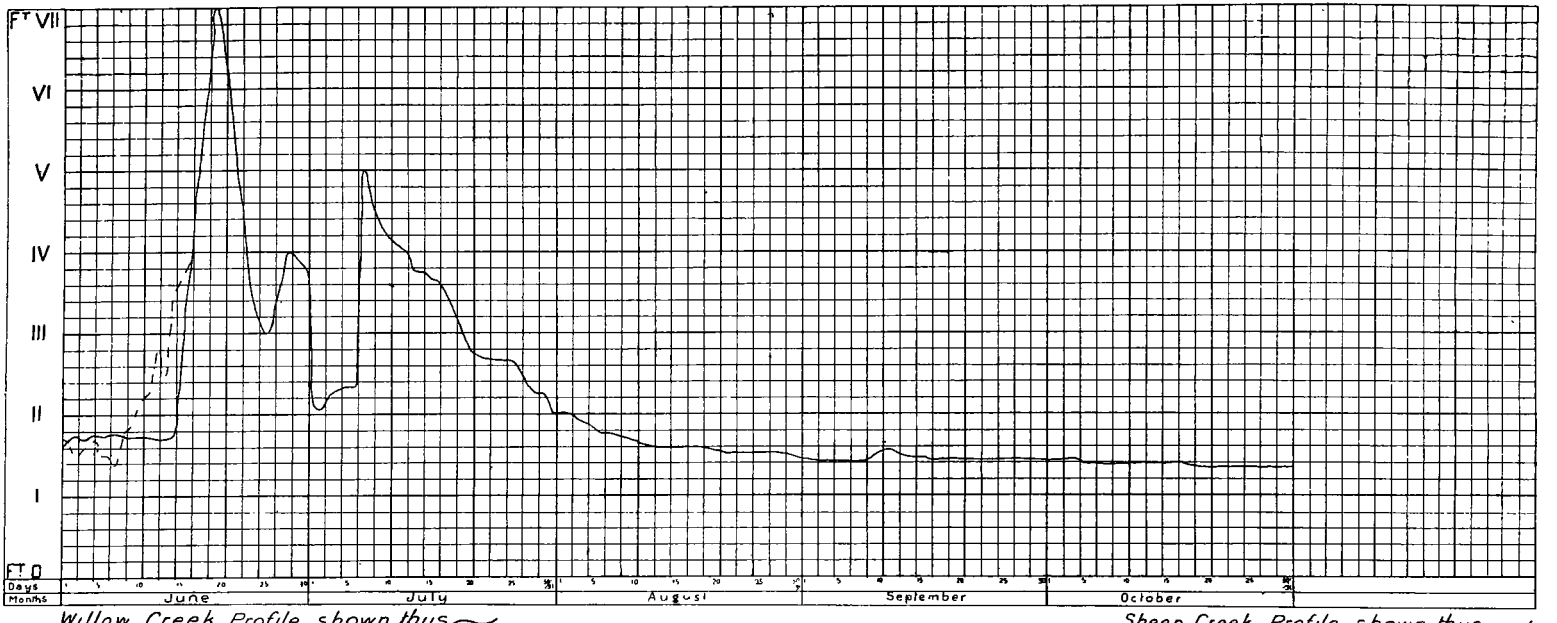


Fish Creek Profile shown thus ~

Nose Creek Profile shown thus ~

Diagram Showing Rise and Fall of Willow and Sheep Creeks 1897

No 2.

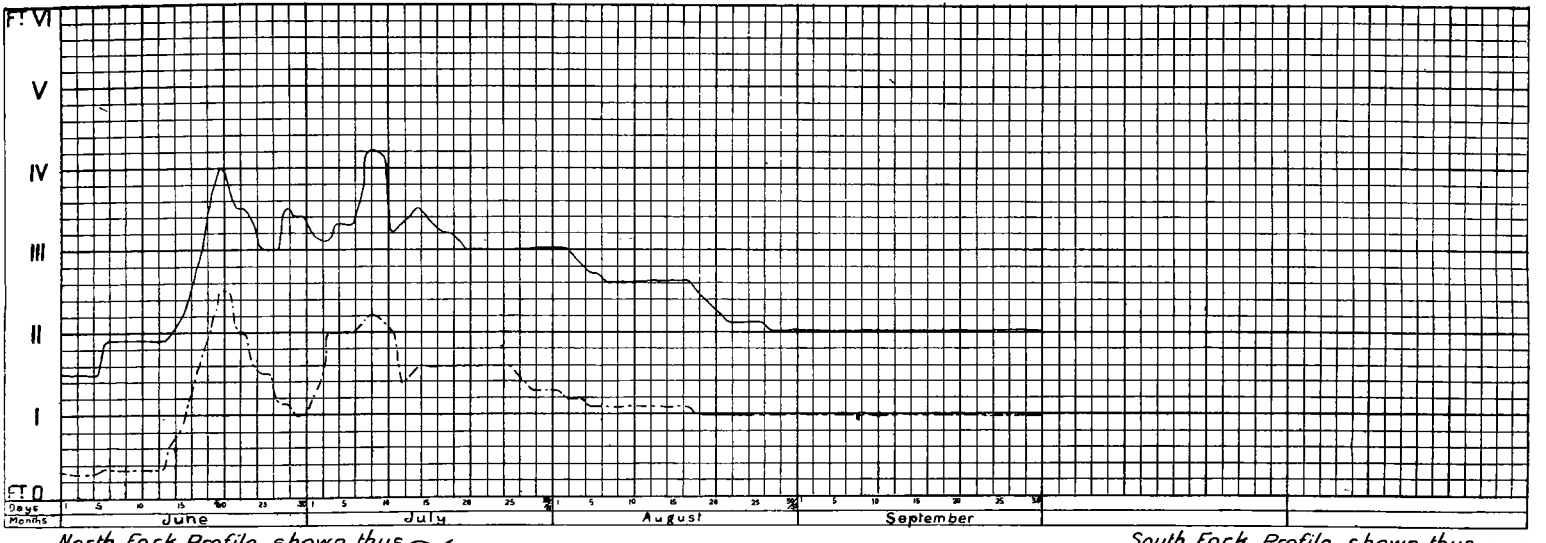


Willow Creek Profile shown thus ~

Sheep Creek Profile shown thus ~ ~

June Floods carried away Bridge and Gauge Rod

DIAGRAM SHOWING RISE AND FALL OF NORTH AND SOUTH FORKS OF MOSQUITO CREEK 1897 No 3

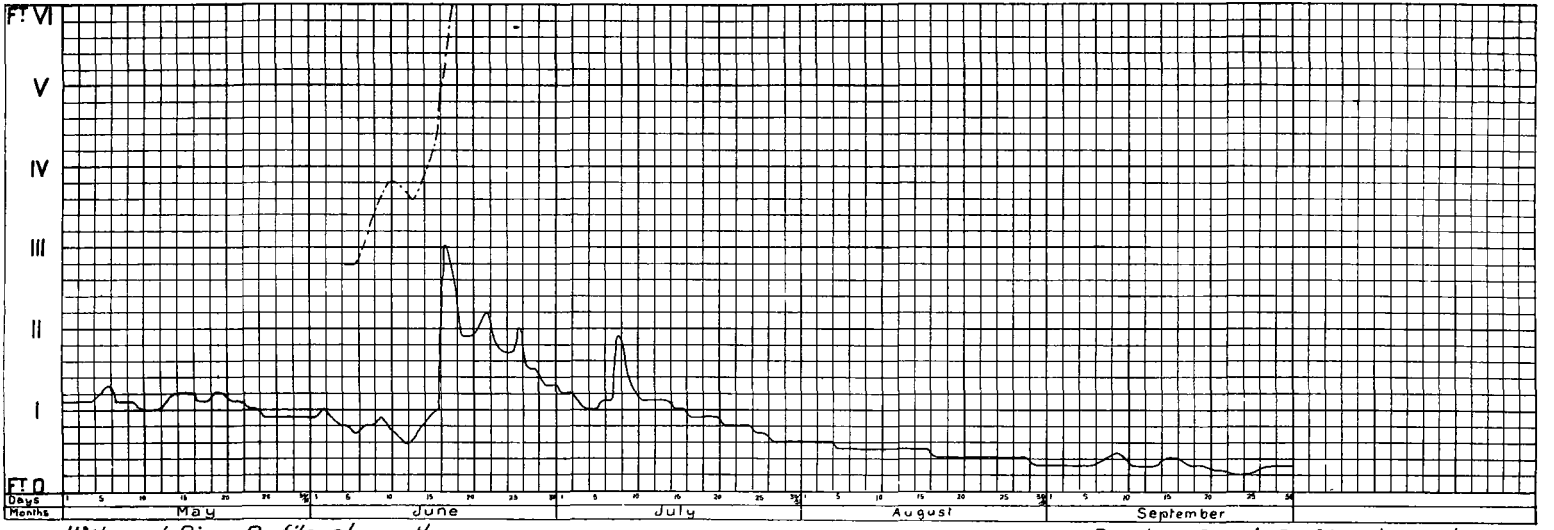


North Fork Profile shown thus ~

South Fork Profile shown thus ~

DIAGRAM SHOWING RISE AND FALL OF HIGHWOOD RIVER AND PINCHER CREEK 1897

No 4



Highwood River Profile shown thus ~ ~

June Floods carried away Bridge and Gauge Rod

Pincher Creek Profile shown thus ~

DIAGRAM SHOWING RISE AND FALL OF OLD MAN RIVER FROM MAY TO SEPTEMBER 1897

No 5

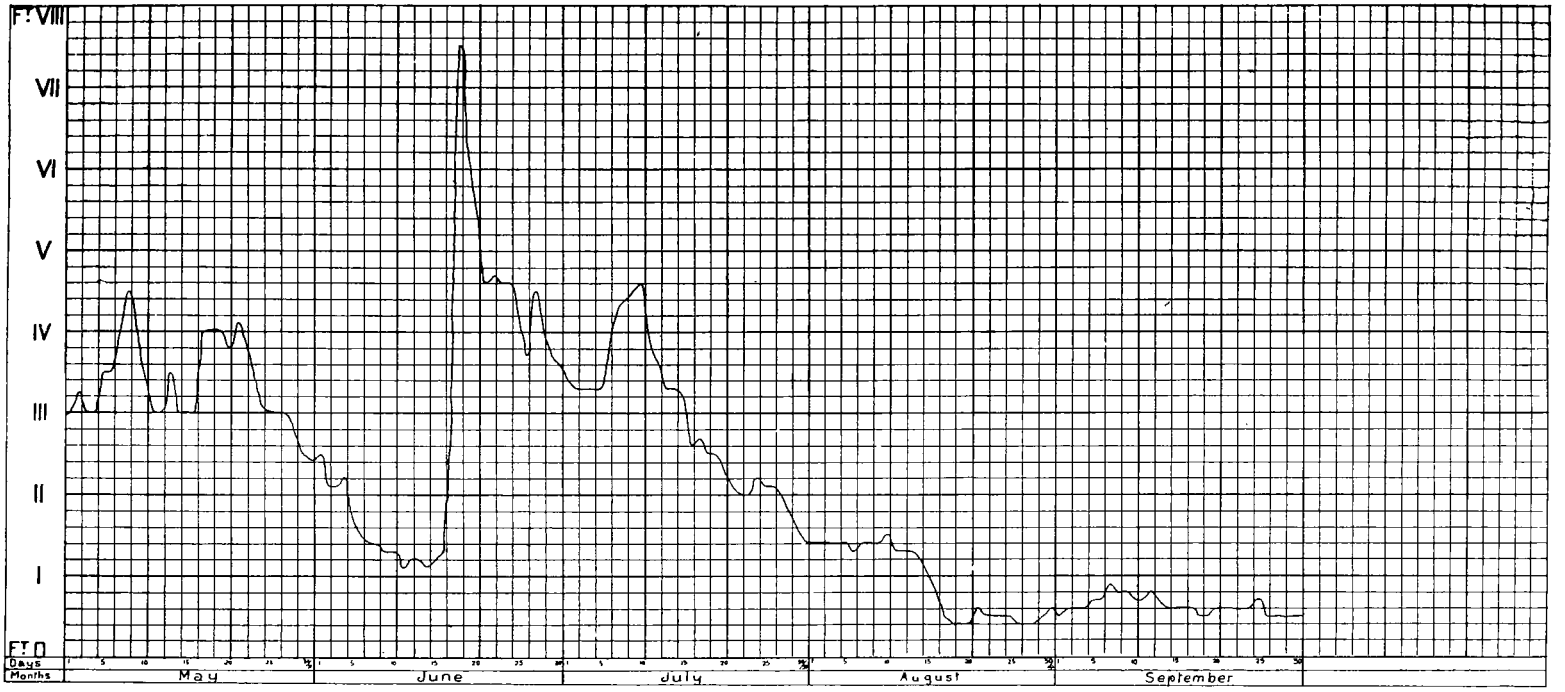
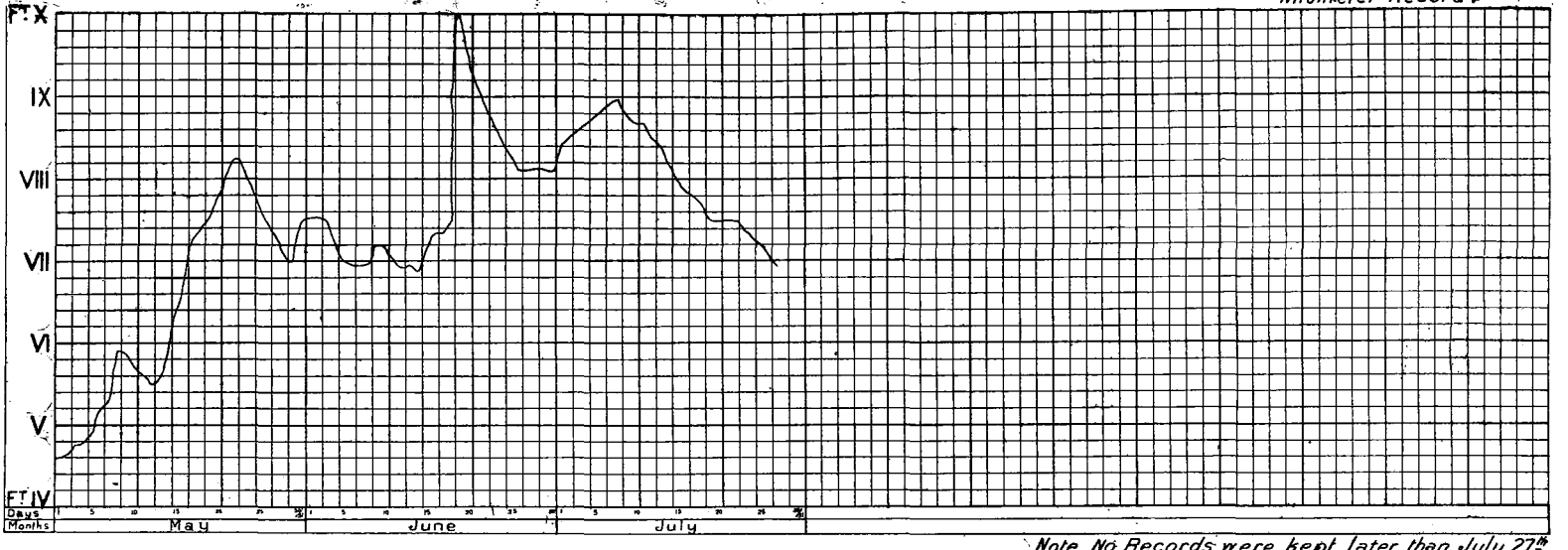


DIAGRAM SHOWING RISE AND FALL OF BOW RIVER FROM MAY TO JULY 1897

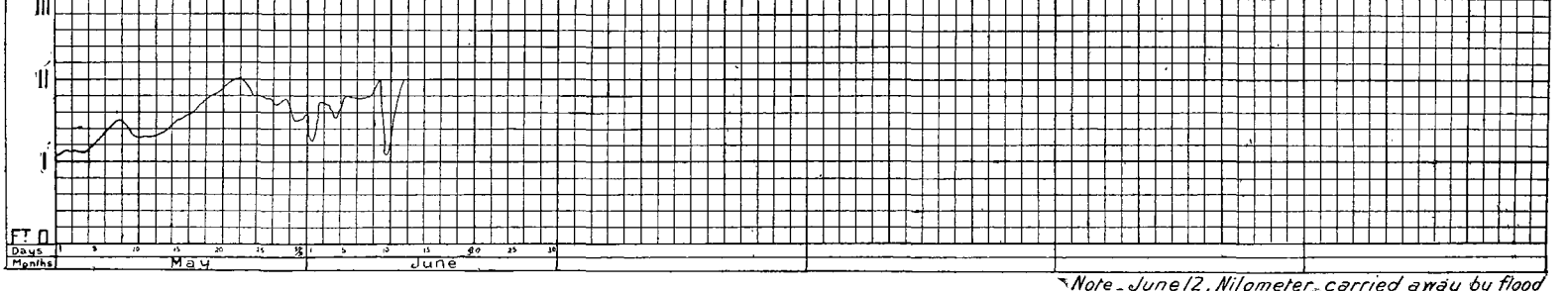
Nilometer Record No 6



Note_No Records were kept later than July 27th.

DIAGRAM SHOWING RISE AND FALL OF ELBOW RIVER FROM MAY TO JUNE 1897

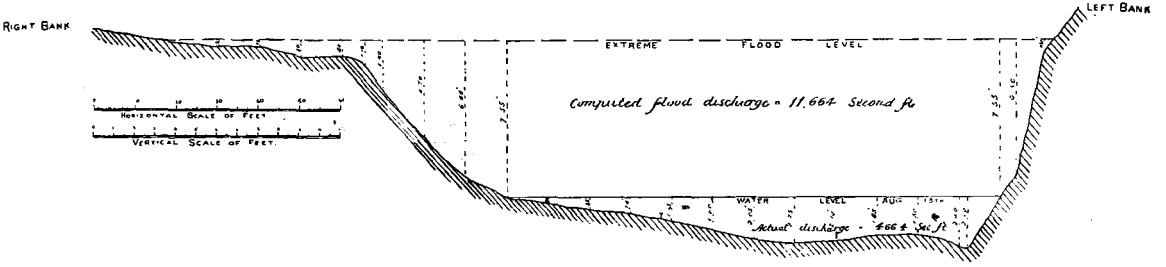
Nilometer Record No 7



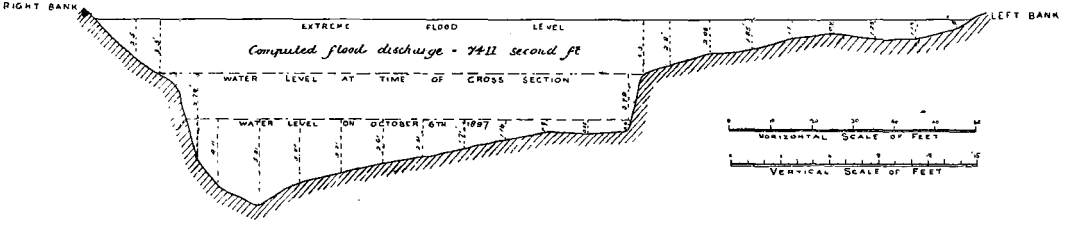
Note_June 12, Nilometer carried away by flood

No 8

CROSS-SECTION OF
HIGHWOOD RIVER
AT EXTREME FLOOD LEVEL
JUNE 1897



CROSS-SECTION OF
JUMPINGPOUND CREEK
AT EXTREME FLOOD LEVEL
JUNE 1897



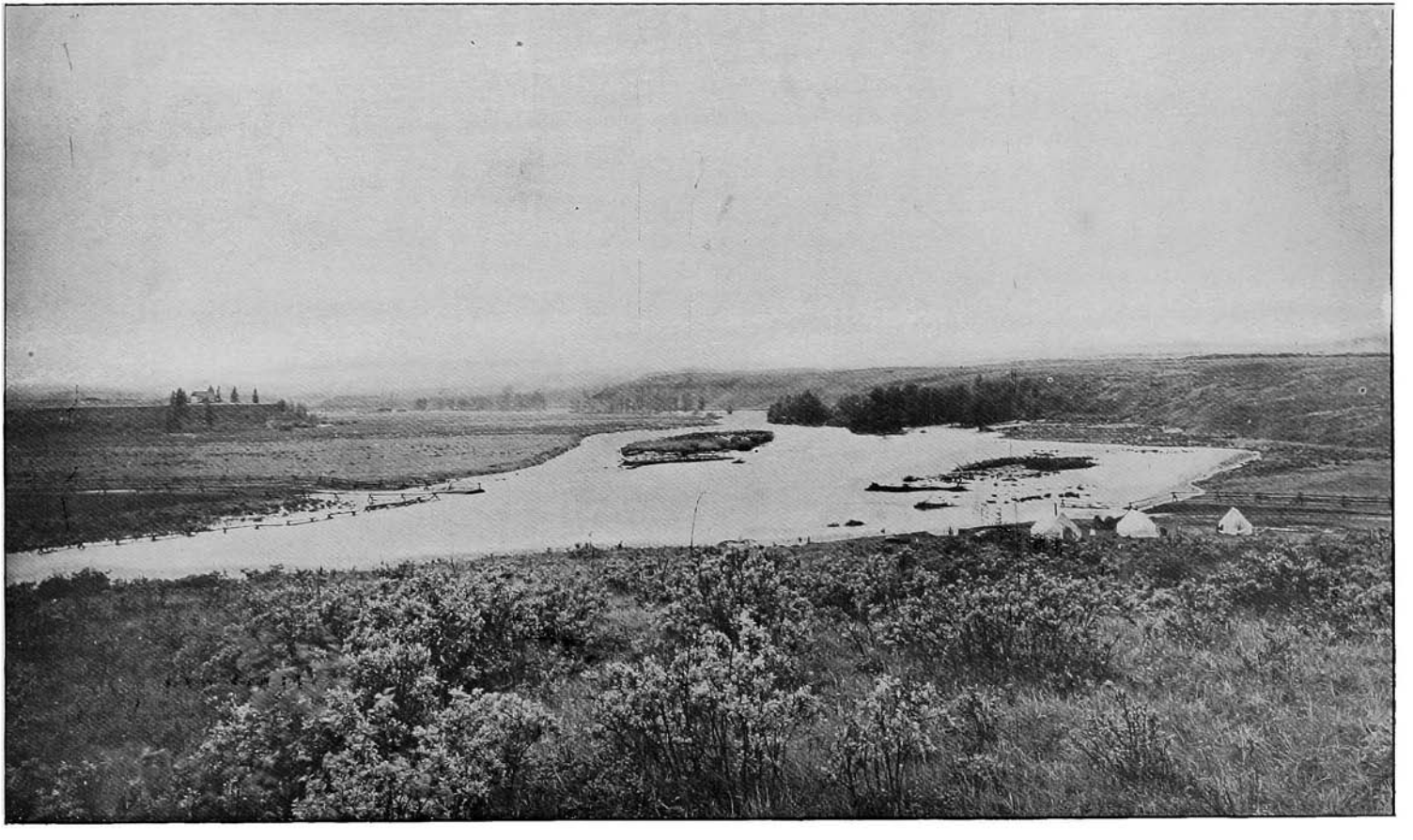


PLATE I.—JUMPING-POUND CREEK AT EXTREME FLOOD, JUNE, 1897.



PLATE II.—LOWER FALLS AND CAVE ON ELBOW RIVER.

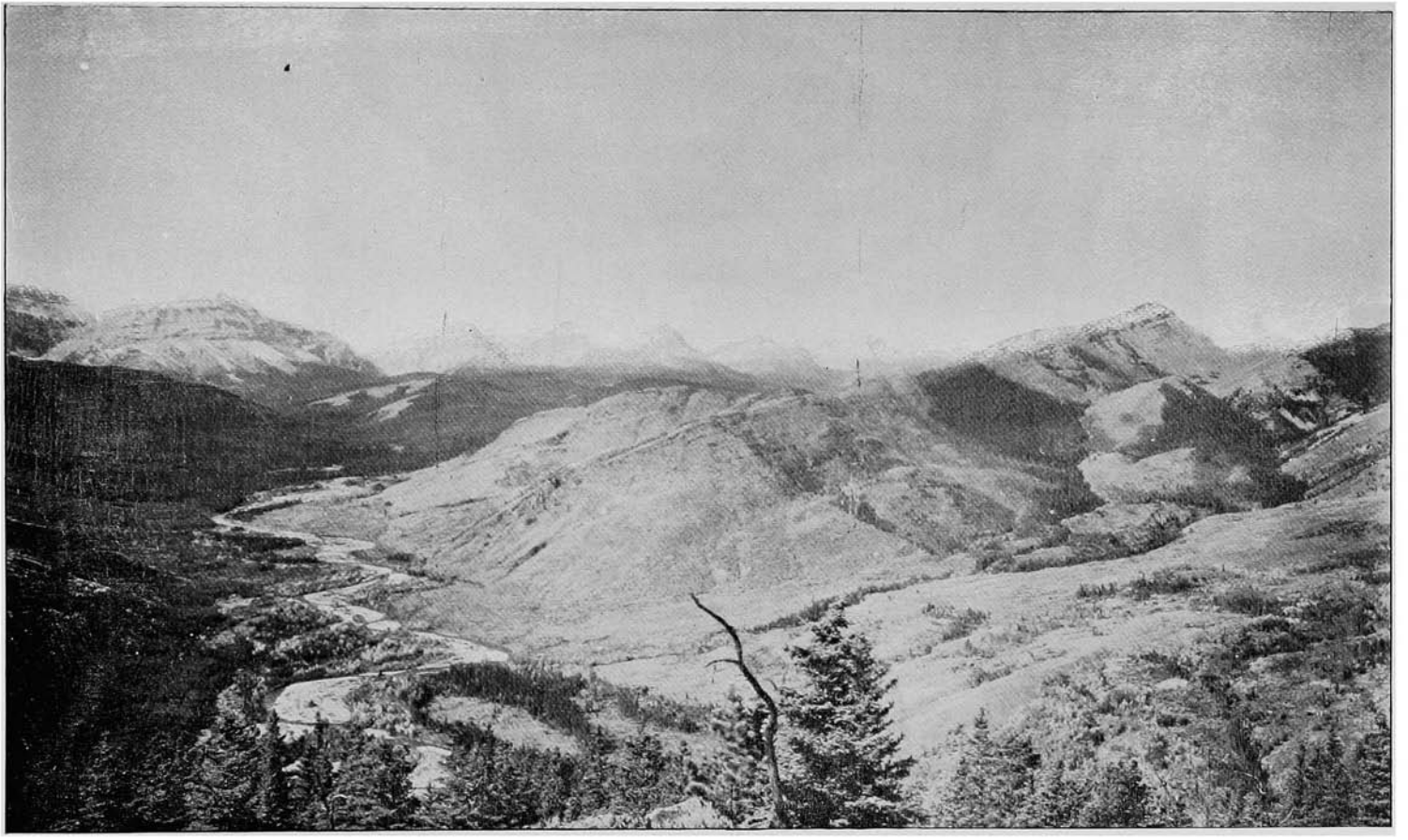


PLATE III.—LOOKING UP HIGHWOOD RIVER FROM THE GAP.

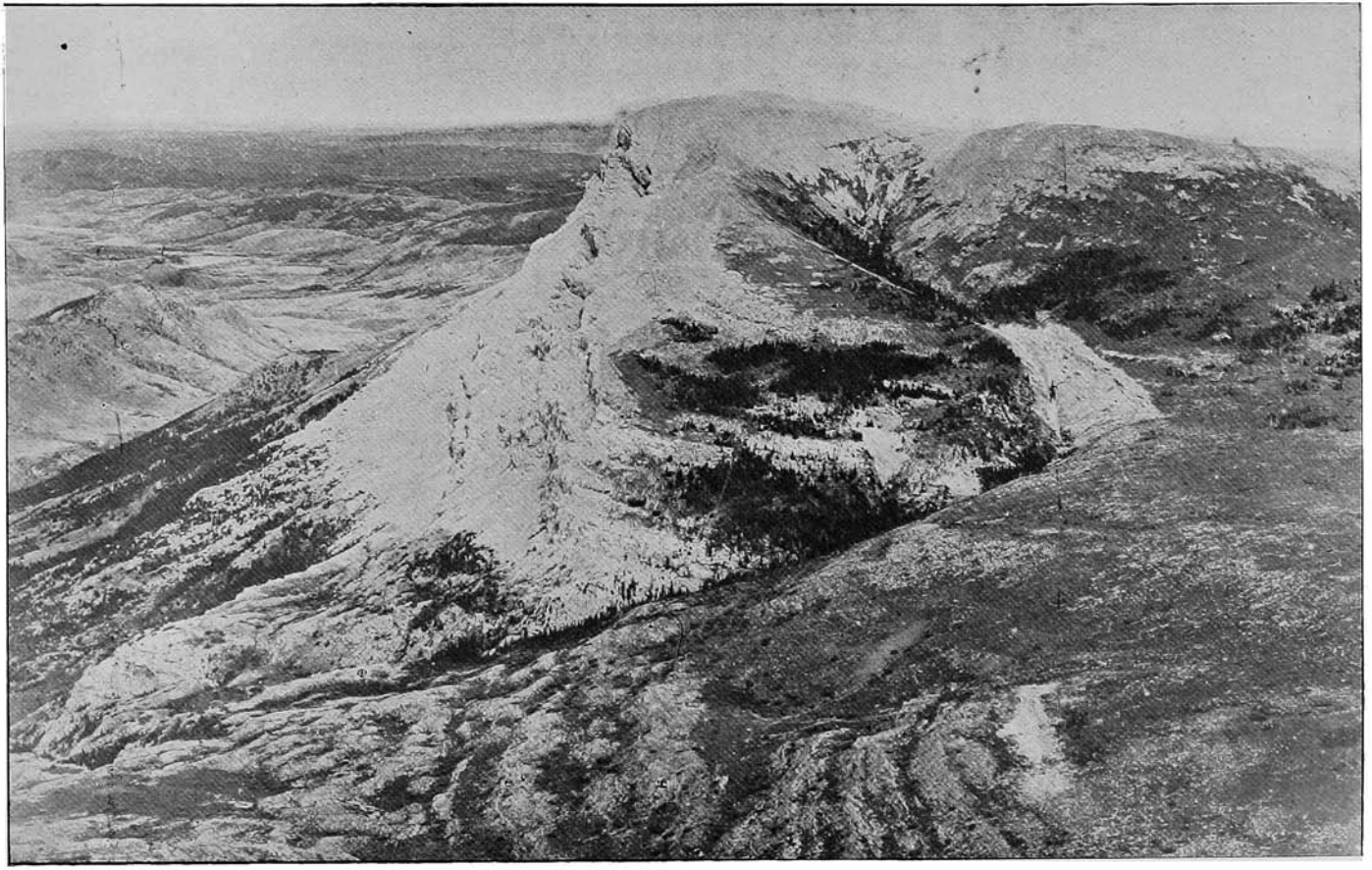


PLATE IV.—SENTINEL MOUNTAIN, SHOWING HEAD OF THE MIDDLE FORK OF HIGHWOOD RIVER (PEKISKO CREEK).

IRRIGATION SURVEYS, 1898.

REPORT OF ARTHUR O. WHEELER, D.L.S., IN CHARGE.

CALGARY, 20th March, 1899.

J. S. DENNIS, Esq.,
Deputy Commissioner,
Department of Public Works,
Regina, Assa.

SIR,—I have the honour to submit the following report on the operations of the Irrigation Surveys Office at Calgary, Alberta, during the past year.

Under date 23rd of May, 1898, I was directed by the Surveyor General of Dominion Lands to report to you at Regina for instructions with regard to Irrigation surveys, and did so upon the 30th of the same month.

I then proceeded to Calgary and took charge of the Irrigation Surveys office and staff at that place, commencing immediately to organize the parties, and other works detailed to me when at Regina, and in your instructions of June the 7th.

The instructions given to me may be briefly outlined as follows :—

It was proposed to place three parties in the field ; also to retain one assistant in the Calgary office to look after the evaporation and hydraulic investigations being carried on in the vicinity, and at the same time attend to the office work necessary during the summer.

Party No. 1, under my personal supervision in the field, was instructed to continue the photo-topographic survey of the portion of the eastern watershed of the Rocky Mountains, supplying the irrigation belt of Alberta, in the same manner as previously carried on by Division B. of the Irrigation Surveys.

The first work to be undertaken by this party was the completion of the measurement of the base selected in the Highwood river valley last fall ; then having erected primary signals at chosen points, to carry the main triangulation southward to tie on the base and cover the ground to the present southerly limit of the survey ; at the same time latitude and azimuth observations were to be taken. The photographic work and secondary triangulation were next to be extended over the remaining portion of the Highwood river basin and to the drainage basin of the Oldman river. During the latter part of the season, micrometer traverses of Willow creek and the head waters of the Oldman river were to be taken up, and carried east and south from the heads of the respective streams.

The instruments and methods employed were to be the same as in the past.

Party No. 2, was to be organized for the purpose of obtaining sufficient detail within the blocks of which the boundaries had already been accurately levelled to enable a complete contour map to be made, to show, not only the areas susceptible to irrigation, but also the routes by which water could be brought from the various sources of supply to those areas.

For this purpose the gradient-telemeter level (J. Short's patent), manufactured by L. Casella of Holborn Bars, London, England was to be used for the first time on Canadian Irrigation Surveys. It gives the distance and difference of elevation at the one setting by using a fourteen or sixteen foot rod, divided to hundredths ; thus dispensing with the services of two chainmen as well as doing more rapid work, in that it is possible to take differences of elevation up to 150 feet without moving the instrument. With an ordinary level, the limit of difference in elevation for one setting is confined to the length of the rod, usually sixteen feet.

Briefly, the programme to be adopted was as follows :—Levels were to be carried along the meridian lines of the land surveys system in each township at intervals of two miles, using the gradient-telemeter level; the intervening spaces to be surveyed by the topographer attached to the party in such a manner as would enable complete contour lines to be connected throughout with the corresponding points ascertained by the level on the meridians; thus showing generally the topography and elevation, within the contour interval, of every portion of the township.

It was also desired by the means employed to connect the topography of the foothills section with that of the plains areas, where the elevations become too low, and the contours insufficiently marked, to render photographic methods available.

Party No. 3, was instructed to continue the exploratory surveys commenced last season in Assiniboia, with a view to locating the most suitable points for storage in reservoirs, by the erection of dams, of the spring and freshet discharges of the larger drainage channels, so as to improve the existing water supply for domestic and stock watering purposes; the district to be covered by the survey to comprise that portion of eastern Assiniboia lying east of Moosejaw, south of the Qu'Appelle river, north of township 12, and west of the province of Manitoba.

Party No. 1.

During the past winter, the computation of the foothills triangulation, extended southward from the Bow river valley, was brought up to date in the office of the Chief Astronomer to the Department of the Interior, Mr. W. F. King. It was found necessary to reject one of the primary stations, "Hoffmann," and substitute a more elevated point, "Highwood Divide," in the same vicinity.

The change entailed the re occupation of a number of the primary stations, to obtain the new angles. This work was commenced on the 27th of June, and completed on the 13th of July, considerable delay having been experienced in the meantime owing to smoke from bush fires, and wet stormy weather.

On the 14th, final measurements of the base selected in September of last year in sections 20, 21, 28 and 33, township 18, range 3, west of 5th meridian were commenced a short distance above Ings Bros.' ranch on the north side of Highwood river.

A brief sketch of the methods employed may not be amiss.

Two measurements were made with a steel tape, supplied by Messrs. Keuffel & Esser of New York. It is 100 metres in length, $\frac{3}{16}$ of an inch wide and graduated on each side of the initial point and of the terminal points of each twenty five metres to millimetres for a space of five centimetres. There are no handles, but at each end an elongated ring to be used in stretching the tape.

The makers have furnished a certificate stating that the tape agreed with their standard at a temperature of 62° Fahr. under a 40 lb. pull when unsupported, except at the ends, and a 4 lb. pull when supported throughout its length.

The ground was first measured roughly, and wooden hubs, of not less than six inches diameter, set solidly at the end of each 100 metres. During the fall of 1897, levels had been carried over the base and grades selected for the measurement; the tops of the hubs were now aligned for their respective grades.

The tape was next suspended between the hubs, resting lightly upon them at the initial and terminal points of the 100 metres and supported at seven intermediate points $12\frac{1}{2}$ metres apart, the supports being set to grade.

The supports consisted of tripods. From the apex of each, a copper wire hook was suspended by a hempen string; on these the tape rested.

Thermometers were placed respectively at 25, 50 and 75 metres; in each case, the mercury bulb rested upon the tape and was fully exposed. At certain points during the measurement, distinctly appreciable differences were noted in the readings of the three thermometers for each 100 metres, due probably to differences in elevation above the ground owing to inequalities of the surface, and in several cases to being suspended above water or damp ground.

An ordinary spring balance gave the desired tension.

A specially devised apparatus was used to stretch the tape. When stretched at the required tension, silver headed tacks were driven in the hubs and the initial and terminal index marks brought over them; then, using strong magnifying glasses the positions of the index points were marked simultaneously upon the tacks by a sharp knife edge. The temperatures were taken immediately before, and after this operation. When moving forward to record another 100 metres, no attempt was made to register the hind index of the tape with the mark on the tack made for the front index of the previous measurement; instead, an independent measurement was made at whatever place upon the hubs the tape index happened to come when stretched, and fresh tacks were driven. The difference between the two registrations was then scaled by a boxwood scale divided to ·0005 metres, and applied as a plus or minus quantity to the measurement by account.

Two complete measurements of the base were made; one from south to north, with a 30-lb. tension; the other from north to south with a 20-lb. tension.

The range of temperatures within which measurements were taken was 25°, viz: from 49° to 74°; the large majority, however, were within a very much smaller range.

Near the commencement of the measurement from south to north a comparison was made with D.L.S. standard tape No. 21, 66 feet in length, and at the same place near the finish of the measurement from north to south; a corresponding programme was observed in comparing the standard.

The field records were forwarded to Mr. W. F. King, the Chief Astronomer to be computed in his office. His discussion on, and deduction of results are here given.

CALCULATION OF THE LENGTH OF THE BASE AT INGS.

The length of the base was approximateiy 3,500 metres, and was measured by 35 stretchings of a steel tape 100 meters long from hub to hub. The exact distance between the ending of one stretching of the tape and the beginning of another was measured by a boxwood scale divided to $\frac{1}{2000}$ of a metre.

The tensions at which the tape was stretched were measured with a spring balance.

The temperatures were read by three thermometers at 25 metres, 50 metres and 75 metres from either end of the tape.

The relative elevations of the hubs were determined by means of an engineer's level.

The elevation above the sea was determined by levelling from a known datum.

The points to be considered are :—

(1) Length of the tape used.
(2) Correction for tension.
(3) Correction for temperature.
(4) Correction to the horizontal.
(5) Correction to sea level.

(1.) *Length of tape.*—It has not yet been practicable to make a direct comparison of the tape with the Dominion standard measure. The makers of the tape (Keuffel & Esser Co.), however, state that the tape was correct at 62° Fahr. with a tension of 4 lbs. when supported along its entire length and with a tension of 40 lbs. when hanging, the comparison having been made with a United States standard measure.

Using this a computation of the catenary gives the length of the tape at zero tension when supported along its entire length to be 99·9959 metres.

A comparison of the distance between hub No. 4 and hub No. 5, by the 100 metre tape, and by the D. L. standard tape No. 21, indicates that the 100 metre tape is 2·07 inches, or ·0526 metres, too long. See appended calculation. This would require an addition to the length of the base of 1·8410 metres. But the test of tape No. 21 was made several years ago, October 1891, and January 1892, and the tape may have been stretched by use. Therefore, more reliance has been placed in Keuffel & Esser's test, and the result from it has been used.

The length of the base, as measured with the 100 metre tape before mentioned was

By south to north measurement	3499·2268 metres
By north to south "	3499·5617 "

From each of these must be subtracted the correction to true length of tape = ·0041 x 35 = ·1435 metres, making the lengths

South to north	3499·0833 metres
North to south	3499·5182 "

(2.) *Correction for tension.*—The investigation of the catenary, above referred to, gives the extension of the tape for each pound of tension (when supported along its whole length) to be ·001025 m. This co-efficient agrees nearly with that determined by many observations on tapes of the Dominion Lands standard pattern, due allowance being made for the greater cross-section of those tapes. Hence it has been adopted, pending the determination of a more precise value by direct observations.

The sum of the tensions during the south to north measurement was 1,053 lbs., and during the north to south measurement 706 lbs.

The correction for tension is, therefore :

To the first measurement	+ 1·0793
" second "	+ ·7236

The above is on the assumption that the tape was lying flat. But it was not com pletely supported ; it was hanging in 8 lengths of $12\frac{1}{2}$ metres each.

The computed difference in distance between the ends of the tape due to the sag between the supports is for 20 lbs. ·02208 m. ; for 30 lbs. ·00102 ; and for 40 lbs. ·00057.

The average tension during the first measurement was about 30 lbs. Thus the correction is ·00102 x 35 = .0357 m.

The tension for the second measurement averaging 20 lbs. We have for it the correction, ·00228 × 35 = .0798 m.

Hence we have for the corrected lengths :—

South to north measurement	3500·1269 metres
North to south "	3500·1620 "

(3.) *Correction for temperature.*—The coefficient of expansion of steel is given in the Smithsonian Physical Tables as ·00001095 for 1° centigrade, which is equivalent to ·00000608 for 1° Fahrenheit, or ·0006 of a metre on 100 metres.

The average of the temperature for the first measurement was $\frac{26}{35}$ of a degree above 62°.

The average of the second measurement $\frac{4\frac{1}{6}}{35}$ of a degree above 62°.

Thus the correction to the first = 26 × ·0006 = + ·0156.

And to the second = $4\frac{1}{6}$ × ·0006 = + ·0025 making the lengths, as corrected.

For the first	3500·1425
For the second	3500·1645

(4.) *Correction to the horizontal.*—The base was divided into ten "grades." The upper surfaces of the hubs in each grade were placed in the straight line joining the hubs at the ends of the grades. The relative elevations of the terminal points of the grades were determined by levelling.

The following formula was used:—

Let a be the measured length.
Let x be the horizontal length.
Let b be the difference of level.

Then $a^2 - x^2 = b^2$ and the correction to the horizontal $= a - x = \frac{b^2}{a+x} = \frac{b^2}{2a}$ very nearly.

b, being given in feet, had first to be reduced to metres.

The corrections so determined for several grades were:—

	Metres.
Grade 1	·0009
2	·0095
3	·0096
4	·0038
5	·0125
6	·0009
7	·0036
8	·0056
9	·0042
10	·0014
Total	·0520

This correction is applicable to both measurements, making them 3500·0905 and 3500·1125.

The mean of them is 3500·1015 and the difference between them which is a test of the accuracy of the work, is 22 millimetres, or ·86 of an inch, or 1 in 160,000.

(5.) *Reduction to sea level.*—The mean elevation of the base is 27·5 feet above the hub at the south end of the base.

The elevation above the sea of the south end as determined by spirit levelling is 4,194 feet:

Thus the mean elevation of the base is 4,166·5 feet above sea level.

The latitude of the place is 50° 32′ approximately.

The resulting correction to sea level is 0·6965 m.

And the reduced length of the base is 3499·4050 metres (of the United States Standard).

RESUMÉ.

	South to North.	North to South.
Measured length	3499·2268	3499.6617
Correction to standard	−·1435	−·1435
" for tension	+1·0793	+·7236
" for "sag."	−·0357	−·0798
" for temperature	+·0156	+·0025
" for horizontal	−·0520	−·0520
" to sea level	−·6965	−·6965
	3499·3940	3499·4160

Comparison of 100 metres tape with standard 66 feet tape No. 21.

From Hub 4 to Hub 5, going North.

Distance (5 chs) from hub 4 to hub 8*a* at 10 lbs. tension average temperature 59·6, uncorrected for temperature	3959·7050
Correction to ends of 100 metre tape $= \frac{839.7 - 7.2}{40} = \ldots\ldots$	20·8125
	3938·8925
Correction to tape 21 (tape No. 21 appears to be of standard length, see records of Board of Examiners) to temperature 60° = ·4 x 5 x ·0051	·0104
Corrected distance by tape No. 21 =	3938·8821

Distance by 100 metres tape	99·9760
Correction for tension 30 lbs	+ ·0264
Correction for sag	− ·0010
Correction for temperature 62·3 − 62 = ·3 x ·0006 =	+ ·0002
	100·0016
	39·37079
∴ 100 metres tape is too long	3937·1420 in 1·7401 "

Going South.

Distance by 66 feet tape, 10 lbs. tension, average temperature 64·1.	3959·3300
Corrections to ends of 100 metres tape $\frac{872.3 - 43.9}{40} = \ldots\ldots$	20·7100
	3938·6200
Correction for temperature 64°·1 to 60° = 4.1 x 5 x ·0052 =	+ ·1066
Corrected distance by tape No. 21	3938·7266

Distance by 100 metres tape	99·9619
Correction for tension 20·5 lbs	+ ·0168
Correction for sag	− ·0023
Correction for temperature (68.2 − 62.0) x ·0006 =	+ ·0037
	99·9801
	39·37079
∴ 100 metres tape is too long	3936·3055 in 2·4211 "

Mean of the two results tape = 2·0806 too long.
Correction for sag of the 66 ft. tape ·0072.
Final result: 100 metre tape too long 2·0734 in.

W. F. KING.

OTTAWA, 17th March, 1899.

Base measuring completed on the 30th of July, the primary triangulation was again taken up, and the work of expanding from the base just measured carried on until August the 11th, when it had to be discontinued owing to heavy smoke from bush fires, probably in the vicinity of Crow-nest pass. The smoke had been strongly in evidence for some time, but had not proved an obstacle until it became necessary to sight on signals at a considerable distance. Diagram No. 1, attached hereto, shows the position of the base in the Land Surveys, and the expansion from it to connect with "Okotoks," and "Whaleback," the two most southerly stations of the primary triangulation extended southward from one of the sides of the triangulation up the Bow river, by D L.S. Drewry, previously referred to on page 58 of the General Irrigation Report for 1896.

Plate No. 1, shows the position of Ings Bros. ranche, and immediately to the south of it, the flat on which the base was measured. Near the left hand side of the picture, in the distance, will be seen where the trough of the Highwood river cuts the flat in two; the south end of the base was here situated within 200 feet of the river bed. The north and was located close to Mr. Fred. Ings' house at the base of the hill. The line cut through the low dip covered by brush, extending northwards in the centre of the flat. From south to north end of base there is a fall of 43 feet.

As no further angle reading could be done for the time being, an inspection was made of two small ditches with a view to the issue of final license for water rights; also of a small lake on the height of land between Sheep and Highwood rivers, from which it had been proposed to divert water into Ings creek (shown on Plate 1), and so to irrigate portions of the flats along the north side of Highwood river, the low water flow of Ings creek not being sufficient. The inspections were completed on the 15th of August; they are referred to below in greater detail.

The smoke was still very dense, so it was decided to move the main camp to the head of the middle branch of Highwood river, now named Pekisko creek, and by means of a flying camp proceed down Salter creek to the valley of Cataract creek and up the same to the head of the north-west branch of Oldman river, and there commencing a micrometer traverse, carry it southward as far as possible from the main camp.

In the 1897 General Report, W. J. Mackenzie, first assistant to division "B," describes the traverse of Cataract and Salter creeks at some length. He did not however, reach the head of the former stream, his progress being stopped by the dense growth of timber and the rough character of the valley through which the stream flows.

On the 16th of August, main camp was established on Pekisko creek, about five miles below Sentinel mountain, where the stream rises, and on the 19th, a flying camp was pitched on the divide between Cataract creek flowing to Highwood river, and the north-west branch of Oldman river.

It quickly became evident that a micrometer traverse would be a work of much time and labour, owing to the dense growth of timber in the valleys throughout this section, and it was decided to make a camera survey, notwithstanding the smoke still hanging heavily over the landscape.

Under the atmospheric conditions prevailing at the time, camera work was both unsatisfactory and uncertain, necessitating the occupation of a large number of stations close together and a range of view not exceeding three or four miles. The results, however, have on the whole been sufficient, and the data obtained will provide a fairly good map representation.

The survey embraces a portion of the section shown on Dr. G. M. Dawson's geological map of the Rocky mountains (published in 1886) as the Crow-nest trough, comprising the wide, heavily timbered valley lying between the Highwood and Highrock ranges.

The map referred to is one of very great value, and is remarkable for the skill, accuracy and detail with which the very large area embraced has been shown, considering the rapid nature of the survey.

Extending southward as far as the work was carried and northward to the Highwood river, the country is covered by a dense growth of green timber, spruce, pine and tamarac, the latter chiefly on the divide between the two systems of drainage.

There are areas that have been burnt over, but they are not numerous, and are in most cases thickly covered by second growth pine (*Pinus Murrayana*). The timber generally is not very heavy, but is very thickly distributed; the largest trees will not exceed two and a half feet on the stump and the majority are much smaller.

These timbered areas are of immense value to irrigation; for, not only do they attract precipitation, but also conserve the moisture and distribute it gradually throughout the summer, thus acting as natural reservoirs. The greatest care should be taken to preserve them from devastations by fire. Some idea of the extent and distribution of the timber may be obtained from Plates II. and III.

The survey of the northwest branch was discontinued on the 2nd of September and the party returned to the main camp on the 3rd.

While the photographing was in progress, signals were set and a triangulation extended over the country occupied by the camera for the purpose of fixing the stations. A tie was effected on the north branch of Highwood river with the triangulation of the previous season.

Signals were now set along the valley of the Livingstone river, or north branch of Oldman river, and a survey commenced on the 16th of September, similar to that of the northwest branch, although the smoke was still very dense.

In the interim, a primary signal had been placed on the northerly group of the Porcupine hills, or those lying north of Willow creek.

The Livingstone river heads in the south slopes of Sentinel mountain, deriving its initial supply from bodies of snow lying in the amphitheatres surrounding its source (see Plate IV). It then flows south along the western edge of the south end of the Highwood range hugging the line of lower sandstone elevations connecting the Highwood and Livingstone ranges and forming a break in the heretofore bold and rugged limestone escarpment of the mountains.

An Indian pack trail climbs Sentinel mountain from Pekisko creek and extends south aloug the valley of the stream. From the valley of the Livingstone river, the camera survey was extended sufficiently far west to join with that of the northwest branch of Oldman river, and eastward to embrace as much as could be seen of the lower foot-hills in the neighbourhood of the various streams joining to form Willow creek. The triangulation also was connected with that of the northwest branch and a tie made with the triangulation on the east side of the Highwood range.

On the 24th of September, your telegram instructing me to meet you at Calgary, was delivered on Sentinel mountain, by a Blackfoot Indian.

The weather being stormy and smoke still a hindrance to good photographic work, it was decided to bring in the party, with the intention of reducing its strength and making an attempt to complete the primary triangulation later on, when the customary September snow storm should have dissipated the smoke.

The party was now reduced to two assistants and a cook, and on the 12th of October, a move made south, and work commenced again at the primary triangulation.

Only three stations were occupied; a series of snow storms set in, rendering angle reading impossible along the western side of the triangulation ladder.

On the 3rd of November, the attempt was given up, and the party returned to Calgary, and was disbanded.

SUMMARY OF WORK PERFORMED.

Primary stations occupied	10
Angles read	87
Secondary stations occupied	15
Angles read	170
Camera stations occupied	42
Views taken	189

PARTY No. 2.

The party was placed in charge of Mr. R. W. Macintyre, C.E., who has for several years been employed upon irrigation surveys.

It comprised, in addition to the chief, a topographer, a rodman, a teamster, and a cook, with the necessary transport and camp equipment.

The following instruments were used: gradient-telemeter level, ordinary Y level, three-inch magnetic compass and tripod, prismatic compass, aneroid barometer, hand level and odometer

The section of country in which operations were carried on lies north of the Bow river, extending east to range 26, west of the 4th meridian, and north of township 26; south of the Bow river and west of Highwood river, extending south to township 18; on the west the work is limited by the foot-hills.

This section was selected for a first trial of the methods proposed for the reasons that a considerable portion of it is well settled, that there are a number of irrigation enterprises either in operation or projected within the boundaries named and that the portion lying to the north and east of the Bow river will eventually be served by the Bow river irrigation canal system, of which a preliminary survey was made by Division A of the Irrigation Surveys in 1895-96; and, finally, that it is desired to join the topographical surveys of the plains areas and the foot-hills watershed.

Work was commenced on the 16th of June and carried on continuously until the 7th of October, a period of three and two-thirds months. Although the entire section laid out was not covered, yet the levelling and topography was completed over an area of 776 miles, which, taking into account the facts that the methods were introduced for the first time on our irrigation surveys and that the field work was closed down sooner than originally intended, may be considered as a fair season's work.

Before closing for good, Mr. Macintyre with one member of his party made surveys at High River village for the purpose of diverting the course of Highwood river from its present channel, to prevent the serious inroads now being made upon the village territory during each spring at high water, or in the time of excessive flood, as in June 1897. The work has since been carried on by the Public Works Department of the Northwest Territories Government, and it is understood, is nearing completion.

A survey was also made of a canal to take water from Highwood river, not far above the village, and conduct the same to the head of the Little Bow river, thereby insuring a constant flow in that stream. For a number of years back the Little Bow has not had a steady flow throughout the summer, the water lying at intervals in stagnant pools during the autumn months. As a large section of stock-raising country is dependent upon the stream for its water supply, the canal as soon as completed will be a permanent benefit.

Mr. Macintyre's report in detail of his season's operations will be found attached hereto.

PARTY No. 3.

Mr. J. T. Child, C.E., was in charge of party No. 3.

The purpose for which it was placed in the field has already been stated.

The organization of the party took place at Regina; in addition to the chief, it consisted of an assistant, a rodman, a teamster, and a cook, with the necessary transport and camp equipment.

The work entailed the use of the following instruments: an ordinary Y level, sixteen-foot rod, three-inch magnetic compass with tripod, Lallié current meter, hand level, 100-foot and 66-foot steel band chains.

The beds of the principal streams were travelled along until a suitable site for a reservoir was found, then the position for the dam to create the reservoir was located and information obtained to enable a report to be made of the dimensions, cost of construction and facilities for obtaining material required.

Levels taken in conjunction with a compass traverse gave the superficial area, and an approximate of the capacity. At the same time, a tie was effected with the land survey lines, and the position of the site by section, township, and range established.

The levels have been referred to a permanently planted bench-mark, marked with the letters B.M. and the broad arrow, so that when the block outline system of levels, applied in Alberta, is extended to this section, they can be incorporated.

Measurements of the velocity of flowing streams were taken with the Lallié current meter, to allow a determination of discharge to be made; at the same time high water and flood levels were recorded from existing indications, and the fall of the stream ascertained so that the discharge at these stages could be computed by the use of Kutter's formula.

The latter method was also applied in the case of streams not flowing.

In addition to the work referred to, Mr. Child examined the dams on the Qu'Appelle river at Fort Qu'Appelle and Katepwe and obtained the necessary data for their reconstruction. The necessary surveys also were made for the construction of a dam on a tributary of Cussed creek in the Yorkton district, to divert the flow from the stream named to certain lakes lying to the south and southeast of the point of diversion, by this means filling the lakes, and improving the water supply of the district.

A detailed report from Mr. Child, accompanied by illustrative plans, is appended.

DITCH INSPECTION.

Four ditches were inspected during the summer and duly reported upon, section 24 of the Northwest Irrigation Act requiring that upon completion of the works, an inspection be made prior to the issue of a final license for water rights. The ditches are as follows:—

1. The late James A. Macmillan's ditch, heading from Sheep river in the southeats quarter of section 7, township 20, range 2, west of 5th meridian; to irrigate 799 acres of land.

The main ditch is 1·87 miles long. As at present constructed, the structures are good but the ditch somewhat out of repair; it will supply water to the lands enumerated in the application, but will first require to be enlarged and extended.

2. Samuel Howe's ditch, heading from Macabee creek, a tributary of Sheep river, in the northwest quarter of section 30, township 19, range 3, west of the 5th meridian; to irrigate 252 acres. The system is very crude, but sufficient to irrigate the lands named in the application. The supply of Macabee creek is limited, and excepting at highest water, is not sufficient to fully supply this claim. Unless the supply be considerably augmented by storage no other rights can be given above Howe.

3. Malcolm T. Millar's ditch, heading from a tributary of Sheep river in the northwest quarter of section 2, township 21, range 3, west of the 5th meridian; to irrigate 165 acres.

The ditch and structures were found to be in accordance with the statements of his application, and sufficient to irrigate the land named; the ditch is out of repair but can readily be placed in a serviceable condition.

4th. John and Samuel Hamilton's ditch heading from springs in the northwest and southwest quarters of section 9, township 22, range 2, west of 5th meridian; to irrigate 60 acres. Up to the present time, no work has been done in connection with the application.

5th. A ditch constructed under the authority of the Superintendent General of Indian Affairs, to divert water from Battle river at a point near the Roman Catholic mission on Bobtail's Indian reserve, to be used for power purposes in connection with a grist, saw, and shingle mill erected on Samson's Indian reserve. The structures proved to be quite sufficient for the purpose and in accordance with the application. A series of narrow channels and sloughs along the river flat have been utilized to convey the water diverted, ditch connections being made at necessary points between to shorten the distance and facilitate the flow. Immediately above the mill, a somewhat larger slough has been utilized to construct a mill-pond; considerable embanking has been done on one side and an efficient waste-way put in. The grist mill is built on the edge of an old bed of the river. It is a solid little building in a good state of repair; appended to it are two circular saws and a shingle mill. Generally the system is in good order, and competent to supply the wants of the Indians.

An inspection also was made of a small lake situated in section 13, township 19, range 4, west of the 5th meridian, with a view to diverting water to Tongueflag and Ings creeks, small tributaries of Highwood river, and so increase the supply of these streams.

It was found impossible to report favourably in this connection, for two reasons: first, it was very doubtful if the available supply would more than replenish the loss from the lake through natural causes; second, the natural overflow drained to Sheep river, and provided the water from the lake could be used for irrigation purposes, it could more readily be applied to hay lands on the flats above that stream.

SCHEDULE of Bench Marks established by Party No. 3 in 1898.

No.	Location.	Remarks.
1	In road survey mound, at N E. corner of N. W. ¼ of Sec. 27, Tp. 19 Range 12, W. of 2nd Mer.	Elevation being 11.51 feet above water in Fishing lake on July 4, 1898. This was placed in connection with dam now finished across the outlet of the lake.
2	In mound at N. E. corner of S. E. ¼ of Sec. 19, Tp. 17, Range 13, W. of 2nd Mer.	Elevation 223·39 feet above rail ot C. P. R. opposite station at Indian Head. Station house since moved ¼ of a mile, or so, west. This B. M. is also 28·90 feet above the top of proposed dam in N. W. ¼ of Sec. 20, Tp. 17, Rge. 13, W. of 2nd Mer.
3	In mound at N. E. corner of S. E. ¼ of Sec. 32, Tp. 17, Range 13, W. of 2nd Mer.	Elevation 141·35 feet above rail at C. P. R. station at Indian Head, as above. This cannot be guaranteed as absolutely correct.
4	In mound at N. E. corner of N. E. ¼ of Sec. 14, Tp. 18, Range 13, W. of 2nd Mer.	Elevation 1·89 feet above rail of C. P. R. at Indian Head, as above.
5	In mound at N. E. corner of S. E. ¼ of Sec. 24, Tp. 17, Range 12, W. of 2nd Mer.	Elevation 47.51 feet above proposed top of dam in N. E. ¼ of Sec. 24, Tp. 17, Rge. 12, W. of 2nd Mer.
6	In mound at N. E. corner of N. E. ¼ of Sec. 14, Tp. 17, Range 12, W. of 2nd Mer.	Elevation 5 feet above proposed dam in Sec. 23, Tp, 17, Rge. 12, W. of 2nd Mer.
7	On top of iron bar in mound at N. E. corner of N. E. ¼ of Sec. 36, Tp. 16, Range 8, W. of 2nd Mer.	Elevation 88·72 feet below surface of Pipestone lake in Sec. 8, Tp. 16, Rge. 7, W. of 2nd Mer. (Aug. 6, 1898), and 41. 19 feet below level of spring flowing 2½ galls. per minute in S. W. ¼ of Sec. 31, Tp. 16, Rge. 7, W. of 2nd Mer. This B. M. is also 25·18 feet above rail opposite C. P. R. station at Grenfell; total elevation of Pipestone lake above latter being 113·90 feet. Proposed source of soft water supply to the town of Grenfell is therefore suggested from this lake, and fresh water from the spring above mentioned.
8	On C. P. R. rail over east end of trestle No. 233, over creek in S. E. ¼ of Sec. 12, Tp. 17, Range 8, W. of 2nd Mer.	This B. M. is 3·01 feet above top of proposed dam in S. E. ¼ of Sec. 12, Tp. 17, Rge. 8, W. of 2nd Mer., and 24·89 feet below rail opposite C. P. R. station at Grenfell, above mentioned. The creek is marked Summerberry creek on maps, but is locally known as Patterson creek, a branch of Summerberry creek.
9	In mound at N. E. corner of N. E. ¼ of Sec. 5, Tp. 18, Range 8, W. of 2nd Mer.	Elevation 17·00 feet above top of proposed dam in S. W. ¼ of Sec. 4, Tp. 18, Rge. 8, W. of 2nd Mer.

The bench marks given above have been placed by party No. 3, at corners of the land surveys system close to the points where the practicability of building dams for the creation of reservoirs has been ascertained.

The elevations given are compared with other comparatively known points; a tie also has been effected, in each case, with the levels taken in connection with the reservoir sites, by levelling to the bench mark planted at the land surveys corner and obtaining the direction and distance by the use of the compass and chain.

The bench marks placed consist of the usual iron bars, marked with the letters "B. M.", and the broad arrow.

It is intended, when the topographical survey now being carried on in Alberta is extended to this section, to utilize these bench marks to incorporate the levels now taken for the reservoir sites with those subsequently taken for topographical representation of the surrounding country.

The bench marks have not been numbered pending the extension of the surveys. In the schedule they are numbered in the consecutive order in which they were planted.

SCHEDULE of Mean Temperature for 1898.

Month.	Swift Current, Assa.	Chaplin, Assa.	Regina, Assa.	Battleford Sask.	Pincher Creek, Alta.	Calgary, Alta.	Macleod, Alta.	Medicine Hat, Assa.
Latitude, N.....	50° 20′	50° 27′	50° 27′	52° 41′	49° 00′	51° ′02	41° 49′	50° 01′
Longitude, W...	107° 45′	106° 40′	104° 37′	108° 30′	114° 00′	114° ′04	113° 11′	110° ′37
Elevation above sea level.	2439	2202	1885	1620	3750	3406	3060	2161
	°	°	°	°	°	°	°	°
January.....	17·2 *a*	8·0 *a*	6·2 *a*	5·0 *b*	24·9 *a*	20·9 *a*	28·7 *a*	19·6 *a*
February.....	12·3 *a*	8·3 *a*	3·2 *a*	—0·1 *b*	.....	14·5 *a*	22·2 *b*	16·0 *a*
March.....	13·4 *b*	12·9 *b*	13·2 *a*	11 0 *b*	.....	17·8 *b*	19·3 *b*	17·6 *b*
April.....	36·4 *b*	37·3 *b*	34·2 *b*	34·9 *b*	.....	38·2 *n*	43·1 *a*	41·9 *b*
May.....	52·0 *a*	56·8 *a*	50·3 *n*	53·6 *a*	.....	49·1 *a*	51·2 *b*	54·8 *n*
June.....	59·8 *n*	68·3 *a*	58·9 *b*	59·7 *n*	.....	56·4 *n*	58·3 *b*	61·9 *b*
July	66·3 *a*	66·1 *b*	.....	65·2 *a*	.....	61·8 *a*	69·5 *a*	69·3 *a*
August.....	65·9 *a*	61·8 *a*	63·3 *a*	62·6 *a*	.....	62·6 *a*	67·2 *a*	69·4 *a*
September.....	54·4 *a*	52·3 *a*	53·9 *a*	53·5 *a*	.....	52·3 *a*	56·9 *a*	56·6 *a*
October.....	37·3 *b*	37·2 *b*	35·0 *b*	35·4 *b*	.....	36·9 *b*	40·7 *n*	40·5 *b*
November.....	22·0 *a*	19·9 *b*	20·4 *a*	16·4 *a*	.....	21·7 *b*	28·2 *a*	23·2 *b*
December.....	17·7 *a*	11·9 *n*	11·3 *a*	10·8 *a*	.....	21·4 *a*	.....	20·5 *a*

NOTE.—*a*=Above mean. *b*=Below mean. *n*=About normal. About normal=within 0°·5.

The schedules of mean temperatures, and precipitation referred to in the 1897 report, have been brought up to date, and are now compared on the same basis as those of 1897, viz: with the means of each month of a number of years preceding 1897. The letters *a*, *b* and *n*, in the schedule indicate above, below, and about normal as compared with these means. The data is taken from the annual reports of the Meteorological Service of Canada.

Below the two comparisons are placed side by side. Both years show a predominance of higher temperatures, with a slight increase in 1898, over 1897.

SCHEDULE showing number of months above, below, or normal as compared with the means for each month of a number of years previous to 1897.

Observing Station.	1897.				1898.			
	Above.	Below.	Normal.	No Records	Above.	Below.	Normal.	No Records
Regina.....	6	2	4	.....	7	3	1	1
Chaplin.....	5	6	1	.....	6	5	1	.....
Swift Current.....	6	5	1	.....	8	3	1	.....
Medicine Hat.....	7	4	1	.....	6	5	1	.....
Calgary.....	8	4	.....	.....	7	3	2	.....
Macleod.....	7	4	.....	1	6	4	1	1
Pincher Creek.....	3	4	.....	5	1	.....	.....	11
Battleford.....	5	6	1	.....	6	5	1	.....

Generally above.....	Jan., Feb., April, May, Aug., Sept...	Jan., Feb., May, July, Aug., Sep., Dec.
Generally below.....	March, June, July, Nov., Dec.....	March, April, June, October.
Evenly divided.....	October.....	November.

Generally above, means above mean at a majority of the places observed at.
Generally below, means below mean at a majority of the places observed at.
Evenly divided, above and below at an equal number of points.

SCHEDULE of Precipitation for 1898.

Months.	Calgary, Alta.	Medicine Hat, Assa.	Swift Current, Assa.	Chaplin, Ass.	Regina, Assa.	Battleford Assa.	Pincher Creek, Assa.	Macleod, Alta.
Latitude, North.	51° 03′	50° 01′	50° 20′	50° 27′	50° 27′	52° 41′	49° 11′	49° 49′
Longitude W....	114° 04′	110° 37′	107° 45′	106° 40′	104° 37′	108° 30′	114° 00′	113° 24′
Elevation above sea level.	3406	2161	2439	2202	1885	1620	3750	3060
	°	°	°	°	°	°	°	°
January.....	0·20 *b*	0·45 *b*	0·57 *b*	0·10 *b*	0·10 *b*	0·53 *a*	0·52 *b*	0·30
February.....	0·90 *a*	1·07 *a*	0·82 *n*	0·40 *b*	.....	1·58 *a*	.....	0·53
March	1·57 *a*	1·62 *a*	2·02 *a*	1·30 *a*	0·57 *a*	0·91 *a*	.....	1·00
April	0·29 *b*	1·42 *a*	0·60 *b*	0·00 *b*	R.	0·02 *b*	.....	0·27
May.....	2·05 *a*	0·48 *b*	1·31 *b*	0·03 *b*	0·21 *b*	2·03 *a*	.....	1·59
June.....	3·21 *a*	1·51 *b*	2·56 *b*	2·33 *a*	2·55 *a*	s·24 *a*	.....	1·90
July	3·44 *a*	2·45 *a*	2·81 *a*	0·18 *b*	.....	1·09 *b*	.....	1·57
August.....	1·83 *a*	2·22 *a*	1·79 *n*	0·15 *b*	2·68 *a*	1·58 *b*	.....	4 04
September	0·40 *b*	1·07 *n*	0·90 *b*	1·09 *a*	2·10 *a*	0·46 *b*	.....	0·85
October.....	0·52 *a*	1·71 *a*	1·33 *a*	0·25 *b*	0·30 *b*	0·83 *a*	.....	0·58
November.....	0·30 *b*	1·23 *a*	0·41 *b*	0·62 *a*	.....	0·68 *a*	.....	0·15
December.....	0·40 *b*	0·67 *a*	0·13 *b*	0·00 *b*	0·15 *b*	0·20 *b*	.....	0·80
Total.....	15·11 *a*	16·90 *a*	15·25 *b*	6·45 *b*	8·66	14·15 *a*	0·52	13·58

NOTE.—*a*=Above mean. *b*=Below mean. *n*=About normal. About normal=within 0·1 inches.

The precipitation schedule is far from satisfactory; lack of records at Regina and Pincher Creek for several months of the year during which precipitation is known to have occurred, renders a comparison of less value.

At Calgary the precipitation for February, March and May was greater than that of last year, and also than the average mean; for June it was little more than half that of 1897 and for remaining months it was less than in 1897.

At Medicine Hat the greatest precipitation took place in July and August, with March considerably above the average, and total less than last year, but also above the average.

At Swift Current greatest precipitation in March, June and July, with total about average.

At Chaplin, in March and June, with total about average.

At Regina, in June, August and September, with no records for February, July and November; assuming the rainfall was about the same as at Chaplin, the next point west, the total rainfall for the year would have been about average.

At Battleford the heaviest precipitation was in May and June, with total considerably above the average, but not so great as in 1897.

At Macleod in May, June, July and August, with August considerably in excess, and total fall about the same as in 1897.

For Pincher Creek there are practically no records.

PARTY No. 2, IRRIGATION SURVEYS.

R. W. MACINTYRE, C.E., IN CHARGE.

DEPARTMENT OF THE INTERIOR,
IRRIGATION SURVEYS OFFICE,
CALGARY, 18th March, 1899.

A. O. WHEELER, Esq. D.L.S.,
In charge of Irrigation Surveys.

SIR,—I have the honour to submit the following report of my season's work during 1898, with Party No. 2, Irrigation Surveys.

My party was completed and went into camp at Shagannapi point by the Bow river on June the 8th.

Instructions for the season's work were received from you on June the 10th.

The instrument allotted to me for the survey is known as Short's Telemeter-level; maker, L. Casella, London, England.

On June the 11th, extensive trials were made by me in the vicinity of camp with a view to the testing and adjustment of this instrument. The results were on the whole satisfactory.

On June the 13th, telemeter levels were taken along the east boundary of township 24, range 1, west of the 5th meridian, and compared satisfactorily with the levels established in 1894 on the same line.

At the same time, my topographer was employed in making a pace traverse of different areas, to familiarize himself with his method of work.

We struck camp on the 15th of June and proceeded west, via the Morleyville trail, to a point on the Bow river about two miles southeast of Cochrane.

The district mapped out for the season's work is bounded as follows:—To the north, by the north boundary of township 25, commencing at the northeast corner of range 4, west of 5th meridian, and extending east to the northeast corner of range 27, west of the 4th meridian, a distance of 34 miles.

To the east, by the east boundary of range 27, west of the 4th meridian, commencing at the northeast corner of township 25, range 27 (mentioned above), south to its intersection with the Bow river; thence westerly and southerly along the Bow and Highwood rivers respectively, to the northeast corner of township 18, range 29, west of the 4th meridian.

To the south, by the north boundary of township 18, from the northeast corner of range 29, west of the 4th meridian, to the northeast corner of range 3, west of the 5th meridian.

To the west, by the east boundary of range 3, west of the 5th meridian up to the northeast corner of township 20; by the east boundary of range 4, up to the northeast corner of township 23; by the east boundary of range 5, to the northeast corner of township 24, and by the east boundary of range 6, up to the Bow river near Radnor, on the C. P. Ry. Work was commenced at the northeast corner of township 25, range 4, west of the 5th meridian, Mr. T. D. Greene's elevation (established in 1894) being taken as a starting point.

The general method of field work adopted was as follows:—Telemeter levels were run along each alternate meridian, either north or south, as was most convenient. The topography of the sections lying between the levelled meridians was taken by the topographer, who usually made a diagonal traverse of blocks containing 4 sections.

He would commence, for instance, at the northeast corner of section 34, and pace-traverse a diagonal course to the northeast corner of section 24, passing through the centre of the block at the northeast corner of section 26; at the northeast corner of section 24, he would check on a telemeter-level elevation, and then take a similar traverse course across the next block of 4 sections, checking always on levelled meridians.

In some cases however, of level prairie townships, the main features, such as valleys and ridges, would be traversed quite independently of the sections or levelled meridians.

The source of Serviceberry creek was located by this method, in addition to several important ridges and valleys. The topographer used a prismatic compass, an aneroid barometer, and an Abney hand level; the distances were paced either on foot or on horseback.

A stationary aneroid barometer was kept at the camp and readings were taken hourly, as far as possible. I have not found the barometer work very reliable or helpful, however, in plotting the season's contour work.

The outlined district north of the Bow river, embracing an area of 510 square miles, was commenced on June the 16th, and completed by August the 29th. The outlined district south of the Bow river, was commenced on September 1st, but work was stopped by your instructions on October 7th, 266 square miles having been completed up to that date. Therefore, the total area contoured during the season (June 16th to October 7th) was 776 square miles. The line mileage levelled over and measured by the telemeter was about 440 miles.

The rodman kept field notes of the topography on each side of levelled lines, in a book specially designed for the purpose; each page was divided up into a block of 4 sections intersected by 2 miles of meridian; each section was divided up into squares with sides of 10 chains, and these were subdivided into smaller squares with sides of 2 chains.

The topographer's field book was similar, except that the points of the compass were laid down on each page, and the book was larger in size.

The advantage of this style of book is twofold: the bearing of any object can be sketched in without using a protractor, and a scale is unnecessary.

The rodman's book was used to supplement the topographer's work; it also contained pages for plotting the profile of levels run—thus one page contained the topography on either side of levelled line, and the opposite page the profile to correspond.

The rodman carried a hand level, which he used in connection with his field notes.

The gradient-telemeter levels were quite satisfactory, the difference in checking being as a rule from 0·0 to 2 feet.

The gradient-telemeter measurements were checked when practicable every half mile, at the $\frac{1}{4}$ section, and section corners. The distance usually checked within a few feet of the theoretic.

The accuracy of an ordinary level over a gradient-telemeter level is undoubtedly superior, because, in the case of a level, the elevations are taken from direct horizontal readings; whereas, with a gradient-telemeter level the elevations are obtained indirectly, and depend upon the accuracy of the distance measured by the instrument, from itself to the rod.

As the gradient-telemeter level is the first instrument of its kind to be used on the Canadian irrigation surveys, a brief description is herewith appended:—

The main features are:—the measurement of distance without the use of a chain, the computation of elevation by means of vertical angles and the automatic method of obtaining gradients on slopes.

Distance is obtained by taking two readings at different vertical angles on the rod, which is an ordinary engineer's levelling rod divided to hundredths of a foot.

The horizontal circle of the telemeter is graduated from $10\frac{1}{2}$ up to 1,200. Certain stated numbers on the circle are designated as pairs, and must always be used in conjunction with one another for the double readings necessary in this work. The entire upper surface of the horizontal circle is shaped to form a curve, so that when the telescope is revolved it is mechanically tilted either up or down, as desired. If the telescope tilts upwards when revolved, the leveller need only reverse it end for end in the Y's to obtain the opposite result, viz., a downward tilt; in fact one end of the lower bar bears

the word "Rise," and the opposite end "Fall," so that the leveller merely has to keep the telescope eyepiece over the word applicable to his sights.

For example: suppose that a steep rising bank has to be levelled up; the leveller places the eye piece end of his telescope over the word "rise"; he then clamps the index at zero on the horizontal circle and levels the instrument as if it were an ordinary Y level. After this he revolves the telescope until the cross hair intersects the rod, near either extremity. The position of the index on the vernier is then noted and the most adjacent pair selected. Suppose this pair to be $12\frac{1}{2}$ and $16\frac{2}{3}$; the reading at $12\frac{1}{2}$ is 12 feet, and at $16\frac{2}{3}$, 4 feet, which gives a distance of 800 feet from instrument to rod, because the difference between the two readings of any pair is the horizontal distance in feet, counting each hundredth of a vertical foot on the rod as one foot horizontal. Thus, distance is obtained by the simple method of subtracting the less from the greater reading.

The ground elevation of the rod above the ground elevation of the instrument is computed, for a "full" reading, by dividing either one of the pair numbers into the horizontal distance, then adding the rod reading of the pair number used to the dividend and subtracting the height of the instrument from the result. For a "rise" reading, the height of instrument is added and the rod reading subtracted, just reversing the "fall" computation.

The gradient of the ground surface between instrument and rod is obtained by revolving the telescope on the horizontal circle until the reading on the rod corresponds with the height of instrument; then the number to which the index points on the horizontal circle represents the distance in which a rise, or fall of 1 foot occurs. For example: the height of instrument is 5·0 ft. by revolving the telescope the cross hair is brought to intersection with this number on the rod; the index now rests at 75·7 =gradient, 1 foot in 75·7 feet. The taking of gradients in this manner forms a valuable check on the levels.

The telemeter can be used as an ordinary Y level by reading the rod with the index clamped at zero, then revolving from zero to 100 (to obtain distance), 0 and 100 being a pair. To work the telemeter level to its best advantage, a long base is necessary; that is to say, the longer the horizontal base is, the greater the vertical angle will be. My greatest vertical distance, taken at one reading, was 138 feet, and the base (or distance from instrument to rod) was 1,415 feet. The rod used being a 16-foot one, limited my length of base to 1,600 feet theoretically, but practically to between 1,500 and 1,600 feet.

The gradient-telemeter level is particularly adapted for preliminary surveys, as chaining, traversing and levelling, can all be done with one man (the rodman).

Courses can also be adopted that would be quite inaccessible to chainmen.

In making a traverse of Highwood river during October, I had only a rodman, and pursued the following method: After setting up the instrument, the telescope would be sighted on rod (as picket) and compass reading noted, then readings for elevation and distance would be taken, and the instrument moved on to rodman's station; rodman would proceed to next station, and the above operation be repeated. No backsights were taken, the height of instrument being established from the traverse station elevation, by measurement on tape or rod.

In closing my report I append an example of a rise and fall reading respectively, taken in the course of the season's field work with the gradient-telemeter level.

Sight.	Pairs.	Readings.	Dist. feet.	H. I.	Rise or fall.	Check gradient	Result.	
–Foresight...	11⅛ and 10	15·55, 1·40	1415	4·88	–138·02	10·3	10) 1415	= 141·5
							Add rod r'd'g at 10.....	1·4
								142 9
							Deduct H. I.....	4·88
							Result.....	138·02
							Check gradient $\frac{1415}{138·02}$	= 10·25
+Backsight..	20 and 16⅔	3·37, 17·00	1363	4·95	–69·73	19·6	20) 1363	68·15
							Add H. I..... ..	= 4·95
								73·10
							Subtract rod r'd'g. at 20	3·37
							Result.....	69·73
							Check gradient $\frac{1363}{69·73}$	= 20·1

The season's contour work has all been plotted on township sheets (40 chains to an inch scale), and is now being transferred to a large map on the scale of one mile to an inch.

The contour lines have checked and fitted in most satisfactorily, as regards the map work.

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

R. W. MACINTYRE.
In charge of party No. 2, 1898.

PARTY No. 3, IRRIGATION SURVEYS.

JAMES T. CHILD, C.E., IN CHARGE.

IRRIGATION OFFICE,
REGINA, 1st December, 1898.

A. O. WHEELER, Esq., D.L.S.
In charge of Irrigation Surveys.

SIR,—I have the honour to submit the following report of the field operations of party No. 3, of the irrigation surveys during the season of 1898.

In June, 1898, this party, following out your instructions, viz: to examine the different sources of water supply in eastern Assiniboia, and make surveys of suitable locations for the construction of dams and reservoirs to impound water with a view to increasing the supply for domestic and stock watering purposes, commenced work at Fort Qu'Appelle in Assiniboia.

The water in the chain of lakes, delineated on the district maps as "Fishing Lakes," has for some time past been generally decreasing and, in receding from the shores, leaves a beach of decaying organic matter, injurious to the health of the inhabitants along the shores of these lakes. Two dams constructed in the Qu'Appelle river some six years back, one at the outlet of the lake at Fort Qu'Appelle, and the other some twelve miles lower down at Katepwe, with a view to maintaining at a normal level the water in these lakes, had during the spring freshets of this year, become damaged and the lower one washed out.

In running a chain of levels, it was found that the difference in level between the upper and lower of these lakes was a matter only of some two feet. It was decided therefore, to locate for one dam at Katepwe, to fulfil the objects of the two former. The Government of the Northwest, following out this idea, have the construction of this dam now under way.

A cross section and measurements for discharge were made of the Qu'Appelle river at Katepwe on the 30th of June, with the results given below.

CROSS section of Qu'Appelle River.

Meter No. 24.		Location of cross section.	OBSERVER, J. T. CHILD, C. E.
No.	Date.		Measured discharge.
1	1898. June 30....	At outlet of Fishing lake, in S. W. ¼ sec. 27, Township 19, Range 12, west of 2nd Meridian.	Cubic feet per second, 418·92

Remarks:—Water fairly clear; one foot above low water mark; bottom sandy, surroundings the same; lake 150 feet up stream; high water two feet above level of water at present stage; average slope, or fall of stream ·04 per 100=2·1 feet per mile.

Indian Head and vicinity are badly in need of some system for augmenting the domestic and stock watering supply. The settlers at present are largely dependent for water upon melted snow in spring time, and rainfall during the summer months, which, when possible, they impound in hollows and reservoirs.

It is found that some springs issuing from the Squirrel Hills about 7½ miles south of Indian Head, would, to a considerable extent, remedy these conditions. With this in view, suitable sites were chosen for the construction of reservoirs to hold the water, and the runoff from the hills at different places in its course down a natural hollow to Indian Head. A glance at the accompanying plans will show these springs as draining into a muskeg just below; the figures in red give the different elevations from the springs down the course of a stream which, although comparatively dry at present, carries a very considerable body of water in the spring to Indian Head; the assumed datum is the north rail on the Canadian Pacific Railway track opposite the station.

The flow of water from the springs, measured by a gauge board amounts to 30,730 gallons per twenty-four hours; it appears to be of excellent quality, and the elevation of 200 feet above the town of Indian Head would at once suggest a feasible and economical system of water supply by means of a pipe line from the springs.

A suitable place for a dam and reservoir is shown in section 20. The contour around this is at a height of 10 feet above the bottom of the proposed dam. Before the dam is constructed, however, it is recommended that a lower one be built as shown in section 32 and 33.

The advantage would then be a holding back of water coming down through both areas of the marsh, and collecting a very much larger increase of runoff water from the hills in spring, and also the nature of the upper reservoir basin being a spongy muskeg, it should be first drained thoroughly and a large portion of the spongy moss, &c., removed; this could be done while the water is draining on down to the lower reservoir.

It would only be necessary to build a dam seventeen feet high at the lower reservoir to back up the water in the manner shown on the plans, which is a contour of five feet below the top of the dam.

In travelling on down the creek, four smaller reservoirs are met with, that in section 10 wastes along an irrigation ditch, there being no waste way back into the creek around the end of the dam. It would appear, however, that the water this spring flowed over the top of this dam in one place, since built up with rip-rap; this would account, no doubt, for water being caught up by the dams below.

A cross section was made of the dry bed of Squirrel Hills creek at the proposed site for the lower reservoir dam, and the slope of the bed ascertained. The result as computed by Kutter's formula, with a friction factor (n), of ·035, is given below for high water level.

Cross section of Squirrel Hills Creek.

No.	Date.	Location of Cross Section.	Computed Discharge.
	1898.		Cubic feet per second.
2	July 6..	At proposed site for lower reservoir dam in N. W. ¼ Section 33, Township 17, Range 13, west of 2nd Meridian.....	30·68

Remarks.—Average slope of channel ·15 per 100 = 7·92 feet per mile; character stiff clay to one foot above bottom, grass above; water runs only in spring and after heavy rains; two springs in section 20, of same township and range, have a continuous discharge into a muskeg at the head of the creek, the one in the N. W. ¼ flowing 2·5 cubic feet per minute, and the other in the S. W. ¼, 1·02 cubic feet per minute, both measured by gauge board.

Redfox creek, situate between Indian Head and Sintaluta, was next reconnoitred from where it crosses the Canadian Pacific Railway to the southern boundary of township 17.

It has a considerable flow in the spring time, but soon runs dry. Two reservoirs were located; one in section 24, township 17, range 12, west of second meridian; the

other in sections 10, 14, 15, and 23, of the same township; the latter will probably embrace something over 100 acres, with fifteen feet of water at the dam.

The survey and contours for both these reservoirs were completed and bench marks planted in the adjacent section mounds.

A cross-section of the dry bed of the creek was made at the proposed site for the dam in the south-east quarter of section 23. The results are here given in schedule form.

CROSS-SECTION OF REDFOX CREEK.

AT HIGH WATER LEVEL.		Location of Cross-section.	OBSERVER, J. T. CHILD, C.E.
No.	Date.		Computed discharge.
3	1898. July 20.....	At proposed site for reservoir dam in S. E. ¼ section 23, township 17, range 12, west of 2nd meridian.	Cubic feet per second, 50·48

Assumed friction factor (n) = ·035.

Remarks.—Average slope of channel ·13 per 100 = 6·86 feet per mile; character of channel, stiff gumbo in bed; creek at the highest in spring, and unless augmented by rainfall runs dry during summer.

The height of land between the headwaters of Redfox and Moose-mountain creeks was now examined with a view to ascertaining the possibilities of diverting the latter creek into Lake Marguerite, and from thence through another small lake to Deep lake, augmenting thereby the supply of water to the Indian Head district. It was found that such a scheme is within the range of possibility, but the cost of excavating a deep ditch for some miles precludes my recommending the scheme as feasible, more especially as the proposed reservoirs now located, two near Squirrel-hills, and two on Redfox creek, should be deemed ample for the supply of the Indian Head district in the immediate future.

On August the 2nd camp was moved to section 21, township 19, range 10, where at the request of Mr. Dill, M.L.A., a spring was examined; it had a very small flow, measuring only one and a quarter gallons per minute, in a ravine about twenty feet deep, which might be dammed, but owing to the rapid fall would make a very small reservoir.

I here met Mr. Cole, overseer of the statute labour district. He informed me that the great success attendant on boring wells with the new auger, owned by the North-west Government, really did away with the necessity of reservoirs, more especially as the farmers in the district, with very few exceptions, were not stock owners, and moreover, seeing that the grain fields are not fenced, naturally suppose that any public and open water would be the means of attracting herds of stock, which otherwise are compelled to range where water is more plentiful. Consequently a move was made to within two miles of Grenfell at the site of an old reservoir in section 12, township 17, range 8, the dam of which, built seven years ago, had been washed out.

The site is a good one, situated on the main road between Grenfell and Wolseley, and would be a useful watering place for stock being driven along the highway to market, and elsewhere. A survey, therefore, was made for a new dam and reservoir which could be constructed at a very moderate cost.

Pipestone creek to the south of Grenfell was next visited and a ditch laid out through the height of land dividing Pipestone and Summerberry creeks, also a dam located at the foot of Pipestone lakes, at the road crossing to Mr. Skelliter's place. The dam is designed to raise the water in the lakes two feet, forming them into a reservoir, the drawoff from which will be along the ditch above mentioned, into Summerberry creek; thus supplying the Grenfell district, the rail opposite the station on the Canadian Pacific Railway being 113·9 feet below the present surface level of the Pipestone lakes.

The height of land between Pipestone creek and Weed lake, (Escapo lake on maps) was then prospected, with the result that the latter was found to be about ten feet below the former. It was here discovered that the C. P. R. Company had some time previously constructed a ditch, putting in gates, &c., but had abandoned its use since striking a good well near Broadview. The mouth of the ditch has since been dammed by the North-west Government at the request, so I am told, of the settlers below, who complained of their hay meadows being flooded out.

A very good reservoir site is located in sections 30 and 31, township 16, range 6, west of 2nd meridian, suitable for the supply of the Oakshela district; and another in section 4, township 18, range 8, in a ravine tributary to the Qu'Appelle River; this latter could be of very great service to the settlers thickly scattered around, who are for the most part under the disadvantage of having to haul water from the Qu'Appelle valley, in some instances a distance of eight or nine miles.

A cross section was made of the ravine at the proposed site for a dam in the south-west quarter of section 31, township 16, range 6, and data obtained so that the discharge at high water level could be computed by Kutter's formula. The result is here given, ·035 being assigned as the friction factor (n).

CROSS-SECTION OF RAVINE.

AT HIGH WATER LEVEL.		Location of Cross-section.	OBSERVER, J. T. CHILD, C.E.
No.	Date.		Computed discharge.
4	1898. Aug. 15....	Bottom of ravine at proposed site for reservoir dam, in S. W. ¼ section 31, township 16, range 6, west of 2nd meridian.	79·84.

Remarks.—Average slope of channel ·14 per 100 = 7·39 feet per mile; character of channel, stiff clay sides and bottom; water runs only in the spring and after heavy rains: ravine is tributary to the Qu'Appelle river.

The party now moved to Blackwood and prospected the bench land between Sintaluta and Indian Head, but with no satisfactory results.

The site of the Katepwe dam was again visited, and the water measured.

Having received your letter of the 6th of August, instructing me to close down the field work at the end of that month, and subsequently the instructions of the Deputy Commissioner of Public Works dated the 23rd of August, it was decided to proceed to the Yorkton district, and carry out the said instructions, which were as follows:—

GOVERNMENT OF THE NORTH-WEST TERRITORIES OF CANADA,

DEPARTMENT OF PUBLIC WORKS,
IRRIGATION BRANCH.
REGINA, 16th August, 1898.

SIR,—I beg to inform you that application has been received from the local member of the Legislative Assembly for the construction of a dam on Cussed creek in the vicinity of section 33, or 34, township 26, range 5, west of the second meridian, with the object of diverting the flow from this stream into certain lakes lying to the south and south-east of the point at which it is proposed the dam should be constructed. In periods of high water in this creek a certain amount of water flows through a natural channel into the lakes, this channel being shown between the points "A" and "B" on the Yorkton sheet map which is attached hereto, but for some years this flow has not

been sufficient to prevent the lakes in question drying up, and it is now thought that if a dam were constructed, that the total high water flow in this stream, instead of finding its way into the Whitesand river, could be diverted into these lakes through channels, "A B," "C D" and "E F" on plan enclosed, and thus fill up these lakes and improve the water supply of the district.

I have, therefore, to request that after having completed your season's operations, and paid off your party, that you will drive from Indian Head to Yorkton, and will make the necessary survey of the proposed dam site, and run the necessary levels between the points above referred to, and prove that if the dam was constructed that the water could be diverted into the lakes as suggested.

Dr. Patrick, the local member, points out that Mr. John F. Reid, our local inspector in that district, who resides on section 36, township 26, range 5, will probably be able to give you what assistance you may need in making this survey, and also that he is well acquainted with the proposed location for the dam, and the location of the natural channels through which it is expected that water can be diverted into the lakes referred to. I would, therefore, suggest that you should, on your arrival, call upon Mr. Reid, and arrange with him to assist you in conducting the necessary investigation regarding this matter.

I may add that your work should be comprehensive enough to enable us to prepare a plan and specification for the dam, if it is desired to construct it, upon your return to Regina, and also to determine whether any work will be needed upon the natural channels between the lakes in the way of opening them out so as to be sure of an uninterrupted flow of the water which it is desired to divert from Cussed creek into these lakes.

Your obedient servant,

J. S. DENNIS,
Deputy Commissioner.

It will be noticed on the maps of the district that the lakes mentioned are shown in the vicinity of Yorkton; these, however, are now all dry. A survey as to the most feasible method of replenishing them was made, when it was found that Insinger creek, a tributary of Cussed creek, could be diverted along a ditch of 1½ miles, and discharged into the old lake beds, and if not sufficient to entirely replenish them would very materially assist in supplying the settlers with water, which is badly needed in the district.

The Government of the North-west have since taken this matter in hand, the ditch being now under construction.

The work above referred to closed the season's field operations, and the party was immediately paid off.

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

JAMES T. CHILD.

SECTION III.

HYDRAULIC AND HYDROGRAPHIC RECORDS.

DISCHARGE OF STREAMS.

The schedule given below shows the cross-sections and discharge measurements made by parties Nos. 1 and 3, during the season of 1898.

June 16th and 17th, cross-sections were obtained of the Bow and Elbow rivers, to be used in conjunction with the nilometer and gauge rods recording the continuous rise and fall of these streams.

In the case of the Bow river, soundings were taken from the Langevin bridge at Calgary, and of the Elbow from the Canadian Pacific Railway bridge, a short distance above the junction with the Bow.

The measurements for velocity were made with the Price current meter and electric register, the number of revolutions per minute at mid-depth being obtained half way between each two soundings. The computation shows a discharge for the Bow of 15,741.64, and for the Elbow of 1,480·78 cubic feet per second.

Diagram No. 4, exhibits the cross-section of last June compared with one obtained on the 13th of July, 1896. It will be noticed that a considerable change has taken place in the shape of the cross-section, probably owing to the effects of the June floods of 1897.

Notwithstanding that the water stage was higher for the 1898 cross-section than for that of 1896, and also the area greater, viz: 2,275 square feet against 2,043 square feet, yet the computed discharge is smaller, giving 15,741·64 second feet as compared with 17,008·68 second feet for July, 1896.

The explanation will probably lie in the fact that in 1898 soundings and meter readings were obtained for each ten feet of cross-section, while in 1896 soundings were only taken at each twenty feet and but three meter measurements for each of the divisions A. B. and C. of the cross-section, or nine in all, whereas in 1898 there were 29 meter measurements for velocity. The effect would be, that in 1896 the high velocities are applied to a larger area of the cross-section than rightly belongs to them, thus tending to increase the computed amount of discharge beyond the truth.

At the time of the cross-section, the water stood at 8·2 feet on the gauge rod; it subsequently rose to 9·2 feet on the 21st June, the highest point reached.

The cross-section of the Elbow river cannot be said to have been made under the best possible conditions. It was situated too close to the junction with the Bow river and was apparently affected by backwater from that stream. This seems to be clearly shown by the similarity between the two records from both nilometers and gauge rods. The object in view was to obtain a cross-section as close as possible to the place where the nilometer was in operation and, as explained below, it was found impossible to place the nilometer at any other point so as to be of service during the year 1898.

The measurement for discharge showed 1,480·78 cubic feet per second. This may readily be considered as a high water discharge, for at the time of measurement the water stood at 3·5 feet on the gauge rod, subsequently rising to its greatest height at 4·4 feet on the 20th of June; the cross-section is situated in range 1, west of the 5th meridian. In 1894, two measurements for discharge were made of the Elbow river during the month of June, one on the 25th, in range 2, and one on the 30th, in range 4; the former gave 647·4 second feet of actual discharge and 2,113 second feet of computed high water discharge, and the latter 412·2 second feet actual discharge, and 1,458·0 second feet, computed high water discharge.

Again, in 1895 two measurements were made, but at a greater distance from the mouth; only actual discharge at the time was obtained. The first in range 4, with the stream at average high water stage, showed a discharge of 761·28 second feet on the

29th of June; the second in Range 5, gave 972·75 second feet on the 7th of July, but this was during a freshet caused by 3½ days of continuous rain.

There is a note appended to the latter cross-section that very high water would be at least one foot higher, and extreme flood probably two to four feet higher.

Of the four cross-sections made by party No. 3, only the first gives actual discharge, viz: that of the Qu'Appelle river. The remaining three are of the dry beds of the streams.

Having obtained the cross-sections, the fall of the bed was measured by levelling, and the high water discharges computed by using Kutter's well-known formula. In the computations, the friction factor (n) has been set at ·035, which appears a little high for the character of the beds as described in Mr. Child's report; however, as the beds are extremely tortuous, and further, that the cross-sections were made at points where it is proposed to build dams, and not with a view to obtaining a straight piece of channel, it has been considered advisable to place the friction factor higher than would otherwise have been done.

The cross-section and measurements have been made to obtain some idea of the amount of spring flow available to fill the reservoir created.

SCHEDULE showing the measured or calculated discharge of certain streams during 1898, by parties Nos. 1 and 3.

Name of stream.	Point of measurement.	Date.	Actual discharge.	Calculated high water discharge.	Calculated flood discharge.	Measured by
Bow river	Langevin bridge, Calgary	June 16	15741·64	.....	.....	Party No. 1.
Elbow river	C.P.R. bridge, Calgary	" 17	1480·78	.....	.....	"
Pekisko creek	3 chains down stream from traverse station 69.	Sept. 5	9·93	.....	.....	"
Qu'Appelle river	At outlet of Fishing lake, Katepwe, S.W. ¼ Sec. 27, Tp. 19, R. 12, W. 2nd Mer.	June 30	418·92	.....	.....	Party No. 3.
Ravine draining to Qu'Appelle river	At proposed site for reservoir dam in S.W. ¼ Sec. 31, Tp. 16, R. 6, W. 2nd Mer.	Aug. 15	.....	79·84	.....	"
Squirrel-hills creek	At proposed site for reservoir dam in N. W. ¼ Sec. 33, Tp. 17, R. 13, W. of 2nd Mer.	July 6	.....	30·68	.....	"
Redfox creek	At proposed site for reservoir dam in S.E. ¼ Sec. 23, Tp. 17, R. 12, W. of 2nd mer.	" 20	.....	50·485	.....	"

RATING STATION.

In the spring of 1897, as will be seen by referring to the report for that year, a chronograph and electric clock were placed in position at the rating station and connections made to enable irregularities of speed to be dealt with when rating the meters.

The experimental results obtained did not prove altogether a success. In the system employed, the rails were used as a part of a circuit, and attachments placed on the car carrying the meter and at intervals of ten feet along the base, so that as the car passed each, the circuit would be closed, and the instant of closing transmitted to the chronograph and duly recorded.

The above system was applied to the rating of three meters, the speeds being also recorded by a stop watch, in the usual manner, to be employed as a substitute in case the chronograph method was not successful.

The chronograph sheets showed certain irregularities that rendered the results of doubtful value.

Mr. W. F. King, Chief Astronomer, to whose office the record sheets have been transmitted, suggests an improved system in the following remarks :—

REMARKS ON THE RECORDING APPARATUS AT THE CALGARY RATING STATION.

The difficulty of getting proper marking of the chronograph sheet is probably due—

(1.) To defect in the contact apparatus on the car.

(2.) To the use of too strong a current on the chronograph.

I would recommend the trial of a more delicate mechanism for the car contacts. In the first place the using of the rails as a part of the circuit seems to be a bad principle.

The resistance must vary very considerably, so that the current at times is much stronger than at other times, and it is impossible to keep the magnet, by which the signals are transmitted to the chronograph, in delicate adjustment. The lateral oscillation of the car must also give contacts of unequal length. Possibly the following system would answer,—

Lay a wire A. B. C. D. as in figure I, diagram No. 5, along the track, midway between the rails. At the points (A. B. C., suppose) where signals are to be recorded, insert break-circuit contrivances, as shown figure II. The uprights F, f, f′ and G, g′, g″ &c., are springs, and the uprights G, g′, g″, are normally in contact with the small projecting points of F. f, f′, so that, when the car is not passing, the current flows unbroken through the wire A. B. C. D..... Now let a projection on the other side of the car be arranged so that as the car is moved (from left to right in the figure) this projection will successively touch G, g, g′, &c. and slightly moving the springs, break the contacts with F, f, f′, &c. The projection should be made of such form as readily to free itself from contact with the springs as soon as it has touched them. Of course the car can be worked only one way, and it will be necessary to remove the projecting piece when the car is returning. The contact springs may be set in plugs, to fit into proper sockets at A. B. C. D. .. so that they may be removed when the apparatus is not in use. The wire A. B. C. D. ..... should be a stout one.

The advantages of this arrangement would be—

(1.) The resistance not varying, the relay by which the signals are transmitted to the chronograph can be kept in fine adjustment, so as to act promptly.

(2.) A weak current can be used. One gravity cell should be sufficient to work this circuit. A relay acts sluggishly when the current is so strong as nearly to approach the limit of capacity of the magnet.

(3.) The relay will respond more promptly to a break than to a make. Hence the mark on the chronograph sheet is more definite.

For the other connections I would recommend a local circuit for the chronograph alone, and another for the clock. The arrangement wouid be as in figure III.

G, G′, G″, are the batteries.

R, relay on the other circuit, A. B. C. D.. .....

S, relay on the clock circuit.

Ch, chronograph.

Cl, clock.

K, key on the chronograph circuit, which may be used for recording observations taken for rating the clock.

The chronograph circuit passes through the magnet of the chronograph, through the points of the relays R and S, and through the key K. This key must be a break-circuit key. The battery of the chronograph circuit, G, should not be too powerful. One large gravity cell in good order will work well with the above arrangement of the circuits.

As to the battery on the clock circuit, I am not in a position to advise, not having a detailed description of electrical control mechanism of the clock. In the arrangement suggested, however, I assume that the clock breaks the circuit. If I am wrong in this, and the clock makes the circuit, the make may be changed into a break so far as the relay S is concerned, in the manner shown by figure IV.

Connect the battery G″ directly to the relay S, by the wires w, w′. Connect w, w′, by the wires v, v′, with the clock. Then the current from G″ normally passes through the magnet S, and holds the armature tight to it. At the instant, however,

that the clock makes circuit, a short circuit for the battery current is provided by the wires v, v', and the clock, S loses its current, and therefore its magnetism, and the armature of S flies back, breaking the circuit of the chronograph.

If gravity batteries are used it is necessary that they be kept working all the time, whether the apparatus is in use or not; otherwise they become foul, copper is deposited on the zinc, &c. The waste material, however, when they are kept working is not serious if they are made to work through a resistance.

If the distances on the chronograph sheet between successive clock records are not equal, the fault evidently lies with the clock, and can be remedied by proper adjustment of it.

W. F. KING.

Owing to the damage done to the rating station by the floods of June, 1897, and the subsequent disorganization of the Calgary office, it was found impossible last spring to utilize the chronograph and electric clock, the short time available for rating meters being fully taken up in re-levelling the platform, regauging and straightening the track and strengthening the fending piles; in consequence, the ordinary methods had to be resorted to. During the coming spring another attempt will be made to get the chronograph system in working order.

The rating for meter No. 24 is here given.

METER No. 24.

REDUCTION of observations for rating taken at Calgary, Alberta, June 9th, 1898, by rigid method.

R. W. MACINTYRE, *Observer.* J. G. MCINTOSH, *Computer.*

No.	r	t	x	y	$x-x_o$	$y-y_o$	$(x-x)^2$	$(x-x_o)(y-y_o)$	Remarks.
1	25 2	13·8	1·826	7·246	+1·161	+4·547	+1·348	+5·279	Length of base = 100 ft.
2	25·5	17·6	1 449	5·682	+0·784	+2·983	0·614	2·337	
3	25·5	18·4	1·386	5·435	+0·721	+2·736	0·520	1·972	
4	25·4	17·8	1·427	5·618	+0·762	+2·919	0·580	2·224	
5	25·6	18·6	1·376	5·376	+6·711	+2·677	0·506	1·903	
6	25·5	19·2	1·328	5·208	+0·663	+2·509	0·439	1·663	Meter
7	25·3	18·2	1·390	5·494	+0·725	+2·795	0·526	2·026	Vanes immersed 0·8 feet.
8	25·1	36·2	0·693	2·762	+0·028	+0·063	0·001	0·002	
9	25·1	39·8	0·631	2·513	—0·034	—0·186	0·001	0·006	
10	25·1	38·8	0·647	2·577	—0·018	—0·122	0·000	0·002	
11	25·0	44·4	0·563	2·252	—0·102	—0·447	0·010	0·045	
12	25·1	41·6	0·603	2·404	—0·062	—0·295	0·004	0·018	
13	24·9	41·5	0·600	2·409	—0·065	—0·290	0·004	0·019	
14	23·3	68·0	0·343	1·471	—0·322	—1·228	0·104	0·395	
15	22·7	72·6	0·313	1·377	—0·352	—1·322	0·124	0·465	
16	22·9	78·5	0·292	1·274	—0·373	—1·425	0·139	0·531	
17	23·3	78·0	0·299	1·282	—0·366	—1·417	0·134	0·518	
18	23·4	79·4	0·295	1·259	—0·370	—1·440	0·137	0·533	
19	23·6	81·6	0·288	1·225	—0·377	—1·474	0·142	0·555	
20	24·0	77·5	0·309	1·290	—0·356	—1·409	0·127	0·502	
21	20·7	99·0	0·209	1·010	—0·456	—1·689	0·208	0·770	Observations 22, 23, 24
25	21·0	97·3	0·217	1·029	—0 448	—1·670	0·201	0·748	and 26 rejected.
27	20·6	99·7	0·206	1·003	—0·459	—1·696	0·211	0·778	
28	20·7	102·8	0·201	0·973	—0·464	—1·726	0·215	0·801	
29	20·5	101·4	0·202	0·986	—0·463	—1·713	0·214	0·793	
30	19·9	99·5	0·200	1·005	—0·465	—1·694	0·216	0·787	
			17·293	70·160			6·725	25·672	

$x_o = ·665$ $2·699 = y_o$

NORMAL EQUATIONS.

$b + 0·665a = 2·699$, whence $a = 3·817$

$6·725a = 25·672$ " $b = 0·161$

EQUATION FOR RATING.

$$\text{Velocity} = 3·817 \times \frac{\text{Revolutions}}{\text{Time}} + ·161$$

EVAPORATION.

Two pans were again placed in operation, an earth pan, and a water pan; but owing to the unavoidable delay in reorganizing the Calgary office, they were not in working order until the 8th of June. The results are not satisfactory. The earth pan was placed on the roadway passing by the observer's house and fenced around; it was so placed to be under supervision, and if possible freed from outside interference.

The resulting total evaporation from June the 8th to November the 5th is 1,747 feet, an amount that appears altogether too small. It seems likely that a lack of due exposure to prevailing winds has been the cause of this apparently low amount of evaporation; under the circumstances, however, it could not be avoided.

It has been arranged during the coming season, to place an evaporation station on Mosquito creek at the Northwest Mounted Police outpost, about fifty-four miles south of Calgary, where interference is not likely to occur, and there are no obstacles to minimize the full effects of wind, sunshine, precipitation, &c. This point has been selected owing to the fact that there are a number of small lakes at no very great distance, in which observations with submerged tanks can be effectively carried on.

The director of the Meteorological Service of Canada, Mr. R. F. Stupart, of Toronto Observatory, has loaned the Irrigation Surveys Office the necessary instruments to take meteorological observations in conjunction with evaporation, consisting of a mercurial barometer, maximum and minimum thermometers, wet and dry bulb thermometers, anemometer, anemograph, and rain gauges; these will be placed in charge of an observer at Mosquito creek station from April, until the end of October next, and arrangements made to have the meteorological observations carried on for the balance of the year, possibly by the police sergeant in charge of the outpost.

The results of evaporation observations with the earth pan are given in the accompanying schedule.

No results worth publishing have been obtained from the submerged pan, owing to difficulties encountered by the observer. It was placed in the Eau Claire mill pond, the only available still water near Calgary; as the pond is frequently filled and emptied for mill purposes and is likewise the resort and playground of many boys during the summer, the site is not a satisfactory one.

EVAPORATION OBSERVATIONS. STATION No. 1, CALGARY, ALBERTA.

PAN in ground 3 x 3 x 2 feet. Elevation of pan 3406 feet above sea level. Latitude 51° 03', Longitude 114° 04'.

Date, 1898.	Temperature.		Gauge reading.		Difference in feet.		General Remarks.
	Water.	Mean of air for period.	At date.	Previous.	Gain for period.	Loss for period.	
June 8	.....	.....	0·867	0·867	.....	.....	Initial reading.
" 11	.....	.....	0·969	0·867	0·111	0·009	Raining heavily.
" 14	.....	.....	0·991	0·969	0·028	0·006	Rain.
" 17	.....	.....	0·965	0·991	.....	0·026	
" 20	53°	.....	0·925	0·965	.....	0·040	
" 23	57°	55°	0·887	0·925	0·003	0·041	Rain.
" 26	60°	58°	0·849	0·887	.....	0·038	
" 29	57°	55°	0·801	0·849	0·009	0·057	Rain, strong S.E. wind
July 1	61°	55°	0·789	0·801	.....	0·012	
" 4	67°	66°	0·737	0·789	.....	0·052	Very warm ; W. wind
" 7	59°	51°	0·683	0·737	.....	0·054	Hot, S. W. wind.
" 10	68°	63°	0·643	0·683	.....	0·040	
" 13	69°	72°	0·592	0·643	.....	0·051	
" 16	66°	67°	0·582	0·592	0·007	0·017	Rain.
" 19	52°	51°	0·602	0·582	0·042	0·022	"
" 22	58°	52°	0·636	0·602	0·044	0·010	"
" 25	67°	65°	0·616	0·636	.....	0·020	
" 28	64°	58°	0·585	0·616	.....	0·031	
" 31	64°	59°	0·584	0·585	0·006	0·007	Rain.
Aug. 3	66°	63°	0·557	0·584	.....	0·027	"
" 7	63°	61°	0·526	0·557	0·024*	0·055	
" 10	62°	66°	0·500	0·526	.....	0·026	
" 13	62°	63°	0·495	0·500	.....	0·005	
" 16	63°	61°	0·451	0·495	.....	0·044	
" 20	65°	65°	0·420	0·451	0·005*	0·036	
" 23	61°	61°	0·414	0·420	0·002	0·008	Rain.
" 27	60°	63°	0·383	0·414	.....	0·031	
" 30	57°	53°	0·404	0·383	0·034	0·013	Rain.
Sept. 3	53°	48°	0·437	0·404	0·040	0·007	"
" 6	52°	46°	0·426	0·437	.....	0·011	
" 10	52°	50°	0·416	0·426	0·009*	0·019	
" 12	56°	58°	0·396	0·416	.....	0·020	Reading before refil'g
" 12	56°	58°	1·216	1·216	.....	.....	After.
" 13	53°	53°	1·256	1·216	0·073*	0·033	
" 17	53°	54°	1·166	1·256	0·001	0·091	
" 20	52°	53°	1·143	1·166	.....	0·023	
" 24	48°	47°	1·109	1·143	.....	0·034	
" 27	49°	42°	1·000	1·109	.....	0·109	
" 30	42°	36°	1·000	1·000	0·017	0·017	
" 30	.....	.....	1·516	.....	.....	.....	Tank refilled.
Oct. 1	40°	32°	1·506	1·516	.....	0·010	Snowing.
" 4	28°	27°	1·403	1·506	.....	0·103	Ice on tank.
" 7	28°	32°	1·309	1·403	0·010*	0·104	
" 11	42°	37°	1·200	1·309	.....	0·109	
" 14	40°	40°	1·050?	1·200	.....	0·150	
" 17	41°	32°	0·996	1·050	.....	0·054	
" 21	36°	30°	0·980	0·996	.....	0·016	
" 24	34°	32°	0·975	0·980	0·014	0·019	Snowing.
" 28	37°	34°	0·969	0·975	0·001	0·007	"
" 31	40°	36°	0·968	0·969	0·001*	0·002	
Nov. 2	39°	31°	0·945	0·968	.....	0·023	
5	31°	32°	0·937	0·945	.....	0·008	
					0·481	1·747	

Total evaporation, 1,747 feet.

NOTE.—* No apparent reason for this gain. ? This reading is doubtful.

NILOMOTERS.

An automatic register of the rise and fall of the Bow, Elbow, and Highwood rivers has been obtained during the past summer by using the Lallié nilometers described in the 1897 report.

Owing to the fact that there was no professional head to the Irrigation Surveys Office at Calgary before the 1st of June, the nilometers were set up much later in the season than should have been the case. The Bow record commences on the 4th, the Elbow on the 8th, and Highwood river on the 22nd.

There was only just time to catch the highest water of the year on the Bow and Elbow, on the 21st and 20th of June respectively, while on Highwood river the water was already receding from its highest stage. Diagrams Nos. 2 and 3 show the results obtained.

The Bow nilometer was in its old position on Langevin bridge at Calgary; the record is not true beyond the end of August. It appears that the well became filled with silt and the float grounded from that date on; this was not noticed when the record sheets were being changed, and was only discovered while plotting at the end of the season; a comparison with the gauge rod records (diagram No. 6) makes the discrepancy apparent.

Gauge rods were placed on, or close to the nilometer wells for the purpose of affording an independent check, and of providing a datum to start from at the commencement of the observations, and at any other time, should a break in the records occur. In the case of the Bow river, the gauge rod has supplied the information lost by the nilometer. Some slight differences will be noticed in the shape of the gauge rod profiles, due to the fact that the rods were read but once daily, and not on Sundays, while the nilometers kept a continuous record.

These three gauge rods have been referred to bench marks of known elevation and can at any time be replaced in relatively the same position, if necessary.

It will be remembered that the nilometer on the Elbow river was washed away by the June floods of 1897, with the Calgary Irrigation Company's flume to which it had been attached. It was replaced by a new instrument of the same pattern, set up on the traffic bridge across the stream near its mouth. The site is not a good one, but as has already been explained, the late start and proximity of highest water stage did not allow much time for choice, and a better site not being available, the bridge was accepted. From the similarity of the profiles (see diagrams 2, 6 and 7), it would appear that the Elbow is to a considerable extent affected, at the point where the nilometer was placed, by the backing up of water from the Bow river during the higher stages.

The Bow attained its greatest height on the gauge rod at 9·2 feet on the 21st of June, then falling, rose again to 8·5 feet on the 20th of July; in 1896 the highest point was reached at eight feet on the 23rd of July, and in 1897 the stream rose above the ten foot mark on the 18th of June, then falling rapidly, rose again to nine feet on the 8th of July; in the last case, however, the June rise was abnormal.

The high water stages of the Elbow river, as shown by the records, happened at the same time as for the Bow.

For the Highwood river, the highest water seems to have occurred about the 20th of June, but there is no rise in July corresponding to that of the Bow; on the other hand there is a distinct rise in August, with a corresponding though not so marked rise for the Elbow one day later. From a comparison of the nilometer and gauge rod profiles it would appear that the observer was a little erratic in his gauge readings.

On the whole the instruments used have not proved satisfactory, they are somewhat clumsy in make, and require rather delicate handling in setting, and to keep in proper running order. It is proposed to supplement the three now in operation by two hydrographs to be placed respectively on the St. Mary and Oldman rivers; these instruments are now being manufactured in Toronto, Ont., under the direction of Mr. F. Napier Denison, on the staff of the Meteorological Office at Victoria, B.C. They will be similar in construction to the hydrographs used by the Meteorological Service

for tidal observations in various parts of Canada. They will have an eight foot instead of a six foot range; the latter is the range of the three instruments used so far, and in the case of the Bow river has been found insufficient.

SCHEDULE for 1898.—NILOMETERS.

Name of stream.	Location of rod.	Name of observer.	Interval of reading.	Period of reading.	No. of diagram, showing rise and fall.
Bow river...	On Langevin traffic bridge, Calgary.	C. D. Rickards, Irrigation Office, Calgary.	Weekly.	Part of June July, Aug. Sept. Oct.	2
Elbow river.	On traffic bridge, Calgary.	C. D. Rickards, Irrigation Office, Calgary.	Weekly.	Part of June July, Aug. Sept. Oct.	2
Highwood river	On traffic bridge, High river village.	Saml. Heslip, Blacksmith, &c., High river.	Weekly.	Part of June July, Aug. Sept. Oct.	3

SCHEDULE of gauge rods read during the year 1898. Along the line of the Calgary and Edmonton Railway.

Name of stream.	Location of rod.	Name of observer.	Interval of reading.	Period of reading.	Numb'r of diagram, showing rise and fall.
Nose creek.	Railway bridge.	John Galbraith, section foreman, Calgary, Alberta.	Daily.	Part of June July, Aug. Sept. Oct.	7
Sheep river.	Railway bridge.	J. C. Bradford, section foreman, Okotoks, Alberta.	Daily.	Part of June July, Aug. Sept. Oct.	10
North branch of Mosquito creek.	Railway bridge.	Thomas Field, section foreman, Nanton, Alberta.	Daily.	Part of June July, Aug. Sept. Oct.	11
South branch of Mosquito creek.	Railway bridge.	Thomas Field, section foreman, Nanton, Alberta.	Daily.	Part of June July, Aug. Sept. Oct.	11
Willow creek.	Railway bridge.	Geo. Wansborough, section foreman, Macleod West, Alberta.	Each 2nd day.	Part of June July, Aug. Sept. Oct.	10

Along the line of the Canadian Pacific Railway. The Cypress hills watershed.

Name of stream.	Location of rod.	Name of observer.	Interval of reading	Period of reading.	Numb'r of diagram, showing rise and fall.
Maple creek.	Railway bridge.	Geo. Bell, section foreman, Maple Creek, Assa.	Daily except Sunday.	August.	12
Fish creek, Assa.	Railway bridge.	Geo. Bell, section foreman, Maple Creek, Assa.	Daily except Sunday.	August.	13
McKay creek.	Railway bridge.	John Flood, section foreman, Walsh, Assa.	Daily.	Part of June July, Aug. Sept.	12
Boxelder creek.	Railway bridge.	John Flood, section foreman, Walsh, Assa.	Daily.	Part of June Part of Aug.	14
Piapot creek.	Railway bridge.	P. Batter, section foreman, Colley, Assa.	Daily.	Part of July and Aug.	15
Swift-current creek.	Railway bridge.	A. Janson, section foreman, Swift Current, Assa.	Daily.	Part of July and Aug.	15
Seven-persons creek.	Railway bridge.	W. Maughan, section foreman, Medicine Hat, Assa.	Daily.	Part of July.	13
Bullshead creek.	Railway bridge.	W. Maughan, section foreman, Medicine Hat, Assa.	Daily.	Part of July, Aug. Sept. Oct.	13
Ross creek.	Railway bridge.	W. J. Corbett, section foreman, Irvine, Assa.	Daily except Sunday.	July, Aug. Sept. Oct.	14

NOTE.—Most of the streams above named carry a quantity of water only in the Spring, and dry up during the Summer; this fact will account for the readings not being carried beyond August. For the reason before given, records of the early spring months were not obtained.

OTHER GAUGE RODS.

Name of stream.	Location of rod.	Name of observer.	Interval of reading.	Period of reading.	No. of diagram showing rise and fall.
Bow river.....	Langevin traffic bridge, Calgary.	C. D. Rickards, Irrigation Surveys Office, Calgary, Alberta..	Daily except Sundays.	June, July, Aug., Sept., Oct., Nov. and each 2nd day n Dec.	6
Elbow river.....	Traffic bridge, Calgary.	C. D. Rickards, Irrigation Surveys Office, Calgary, Alberta.	Daily except Sundays.	June, July, Aug., Sept., Oct. and Nov.	7
Highwood river.	Traffic bridge, High river village.	Samuel Heslip, blacksmith, &c., High River, Alberta.	Daily.....	Part June, July, Aug., Sept., Oct.	8
Oldman river...	Traffic bridge, Macleod West.	Geo. Wansborough, section foreman, Macleod West, Alberta.	"	Part June, July, Aug., Sept., Oct.	9
Fish creek.....	Traffic bridge, Calgary and Macleod trail..	John Galbraith, section foreman, Calgary, Alberta.	"	June, July, Aug., Sept. Oct.	8
Pincher creek..	Traffic bridge near village.	P. Bertles, sergeant N. W. M. P., Pincher Creek, Alberta.	"	June, July, Aug., Sept., Oct.	6
St. Mary river..	At N. W. M. P. detachment, Colles.	G. S. Cotter, sergeant N.W. M. P., Colles, Alberta.	"	Aug., Sept. and Oct.	9

GAUGE RODS.

The above schedule enumerates the gauge rods in operation during the year, the names of the streams upon which they were placed, the names of the observers, the intervals at which they were read, the period over which the readings extend, and the number of the accompanying diagrams showing the profile of rise and fall.

As previously stated, the readings have been chiefly taken by section foremen along the lines of the Canadian Pacific, and Calgary and Edmonton Railways, and by members of the Northwest Mounted Police force.

For convenience of reference, they are classified as follows:—"Gauge rods along the line of the Calgary and Edmonton Railway," "Along the line of the Canadian Pacific Railway," and "Other gauge rods."

They number twenty-one in all; of these, three were read in connection with the nilometers set on the same streams and have already been referred to under the heading "Nilometers." The rod on the Bow has been recorded subsequent to the river being frozen over by keeping a space open around the gauge.

The rods embraced in the first and last classification are the most important, yielding records of the volume and relative stability of the largest portion of the water supply available for irrigation purposes from the eastern watershed of the Rocky Mountains.

Beyond the fact that the readings were not commenced sufficiently early in the spring, the reason for which has been already stated, they appear, with one exception, to have been well and faithfully kept, and cover most of the period during which the streams are free of ice. Mosquito creek is the exception referred to, the records for the two branches being so very similar as to lay open to doubt the sincerity of the observer. (See diagram 11.)

The highest stage of water for Sheep and St. Mary rivers probably occurred prior to setting up the gauge rods; all others show it during the month of June. Sheep, Highwood and Oldman rivers likewise, show a marked rise between the 20th and end of August, with slight indications to the same effect on the Elbow river and Willow creek: outside of these two distinctive features the profiles are irregular.

Along the line of the Canadian Pacific Railway, the rods were placed on the principal streams draining northerly from the Cypress hills watershed. The climate in this particular section, commonly known as the "Maple Creek district," is more temperate, enabling the successful growth of vegetable, fruit, and fodder crops that cannot be raised either to the east or west of it; such as corn, tomatoes, vegetable marrows, alfalfa, &c.; the question, therefore, of the application of water becomes one of great importance, the more particularly that the substrata is of a porous nature, and most of the streams dry up during the early summer, the supply being absorbed at no very great distance from their origin; as a consequence, the conservation of water for irrigation purposes, in this particular section, becomes a matter of considerable importance, and, on this account, records tending to furnish information concerning water supply are of much value.

Commencing with the most westerly streams, Sevenpersons creek, (diagram 13) appears to have ceased to flow about the middle of July while Bullshead creek shows a freshet in the latter part of August. Ross creek, (diagram 14) and McKay creek, (diagram 12) the two next, appear to have been within the centre of an extremely heavy precipitation during August; two distinct freshets are shown, each of the streams rising over six feet during the latter one. McKay creek first ceased to flow at the end of July, and finally about the 10th of September.

The same freshets appear on Boxelder creek, but to a very much less degree; this stream, also, ceased to flow on the 12th of August, and finally about the end of the same month. In the case of the diagrams of rise and fall for McKay and Boxelder creeks the difference in elevation between the first termination of flow and recommencement is probably due to the freshet commencing to come down between intervals of reading the rod.

Continuing east, there are no records for Fish creek, (diagram 13) beyond the end of August; it appears also to lie without the area of the precipitation shown by McKay and Ross creeks, as there are no indications of a rise during August.

Maple, Piapot and Swiftcurrent creeks (diagrams 12 and 15) furnish no information beyond the end of August, and, except in the case of Piapot creek, show no unusual rise during that month.

The above records are, in themselves, of no great importance, but taken in conjunction with measurements for velocity, they become most valuable. Last summer was the first during which records have been obtained from these streams, and no opportunity then presented itself to have cross-sections made of the beds, levels taken for fall or current-meter measurements for discharge.

It has been arranged for the coming season to commence the gauge rod readings as soon as the streams are flowing free from ice, and to have proper measurements made and sufficient data obtained to enable an estimate to be computed of the amount of discharge at any stage of water.

OFFICE WORK.

During my absence in the field, the office was in charge of Mr. C. D. Rickards, who attended to the correspondence and other matters connected therewith, in addition to his duties of taking the records of the Bow and Elbow nilometers and gauge rods, and the evaporation pans.

It was necessary that I should come in from the field at the beginning of each month to clear up matters of correspondence requiring my personal attention, and to make the payments due for gauge rod readings in the various parts of the district and Assiniboia, also to receive progress reports from parties Nos. 2 and 3, and direct their further movements.

The office work performed during the winter may be briefly outlined as follows:—

Mr. Macintyre, assisted by Mr. McIntosh, who for a part of the season acted as his assistant in the field, has been engaged upon the reduction of the levels taken throughout the section covered by his topographical survey, the plotting of the contours and topography upon township diagrams, drawn on a scale of half a mile to the inch, and the transference of the same to a map embracing his survey, drawn on a scale of one mile to an inch. The work has been tedious owing to the necessity for reducing, checking, and fitting in a quantity of outside data such as railway profiles, ditches, &c. The results, however, are satisfactory, and the map will supply valuable information.

Mr. McIntosh subsequently plotted the cross-sections of streams made during the year, and computed their several discharges. He also computed the current-meter ratings, and made up the various schedules required for the 1897 and 1898 general reports on irrigation, and irrigation surveys, as well as attending to numerous minor details in connection with the office.

Personally, in addition to the routine of the office, I developed the views taken while in the field and spent all available time upon the final topographical maps of the Alberta watershed; it has also been necessary, owing to arrears, to prepare the general report on irrigation surveys for 1897, as well as that for 1898.

The negatives have been properly indexed and numbered, and forwarded to the Surveyor General's Office, to have bromide enlargements made for plotting purposes; these bromides have been duly received. This matter was attended to by H. G. Wheeler, who next computed the angles of the foot-hills triangulation, and made a plot and tracing showing the stations occupied during the last season and their connection with those previously established; he then compiled and draughted a map to show the contours of Mr. Macintyre's survey, and finally, prepared the diagrams of the rise and fall, and other diagrams to illustrate the 1897 and 1898 reports.

Mr. Child having been transferred from Calgary soon after the close ef the season's work, to fill the appointment of Assistant Chief Engineer of the Department of Public Works for the North-west Territories, his returns of survey have been prepared at the Irrigation Office at Regina.

Mr. Rickards' time has been fully taken up by the office correspondence, preparing reports and looking after the Bow river gauge rod, which has been recorded all the winter.

I now submit a topographical map to illustrate the survey made by R. W. Macintyre, C.E.; also plans to illustrate the report of James T. Child, C.E.

At the time the general report for 1897 was forwarded, the plans to illustrate the report of Oliver York, C.E., had not been prepared; as it is intended to publish the general reports upon irrigation, and irrigation surveys for the years 1897 and 1898 in one volume, these plans are now submitted.

Both in the field and in the office, the gentlemen above named, comprising my permanent staff, have given me every possible assistance to conduct the work intrusted to our care in an efficient manner. With the hope that our efforts may have met with some degree of success.

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

ARTHUR O. WHEELER,
Member American Society of Civil Engineers,
in charge of Canadian Irrigation Surveys.

RESULTS FROM IRRIGATION

1897-98

BULLETIN No. 3

RESULTS FROM

The past season was a most unfavourable one for irrigation, being very wet, and works in different parts of the North-west Territories. The lands of some irrigators received from irrigators show that it is impossible to make any reliable estimate of the and summarized, and is issued as

BULLE

INFORMATION

Number.	Name.	Location of Lands.			Acreage under Crop.							
		Township.	Range.	Meridian.	Wheat.	Barley.	Oats.	Rye.	Timothy.	Alfalfa.	Bromus.	Native Grasses.
1	Robert Turner	21	3	5	....	....	....	....	....	....	....	80
2	Joseph Fisher	21	3	5	....	....	....	....	....	....	....	180
3	Hull Brothers	22	1	5	15	10	50	....	175	....	30	45
4	Leeds and Elliott	12	28	4	2	..	56	....	2	....	....	....
5	A. Caseley	29	29	4	5	....	20	....	30	....	1	100
6	J. H. Ellis	24	4	5	....	....	....	....	....	....	....	40
7	Cochrane Ranche Co	5	26	4	..	....	60	....	16	....	10	30
8	W. M. Gunn	9	2	5	3	....	21½	....	4	..	7	....
9	Wm. Moore	10	25	3	....	....	....	....	....	....	....	40
10	D. E. Riley	18	29	4	....	....	....	....	....	....	....	....
11	J. W. McLaughlin	19	29	4	4	..	4	....	....	....	....	....
12	Maunsell Bros	9	26 & 27	4	....	....	60	....	....	....	....	....
13	H. F. Cook	1	26	4	..	....	....	....	....	....	....	60
14	J. J. Head	2	24	4	1	....	5	....	25	....	....	....
15	Indian Depart. (Blackfeet Reserve)	....	....	....	....	73	15	....	....	....	9	....
16	John Nelson	8	1	5	....	....	....	....	....	....	....	60
17	W. C. Wells	26	6	5	....	....	....	....	....	....	....	....
18	C. W. Peterson	23	1	5	20	2	18	....	....	....	..	120
19	Mrs. Annie Dowling	22	3	5	....	5	....	....	9	....	....	....
20	Robert Patterson	9	24	4	....	....	....	....	19	....	....	40
21	H. St. G. Burn	7	2	5	....	....	22	....	....	....	....	....
22	R. A. Wallace	19	28	4	....	....	9	....	13	....	....	....
23	Jones and Smart	19	15	3	....	....	....	10	....	....	....	200
24	C. A. and W. A. Lyndon	12	29	4	....	....	....	....	....	....	....	....
25	A. E. Banister	22	28	4	....	....	....	....	....	....	....	50
26	C. W. S. Elton	8	1	5	....	....	....	....	16	....	6	10
27	S. Brouard	8	25	4	3½	....	....	40	....	....	....	10
28	A. T. Wallace	18	24	3	....	....	10	....	....	....	....	....
29	P. Lachance	8	25	4	9	....	13	....	....	10	....	35
30	Glengarry Ranche Co	12	29	4	....	....	100	....	35	....	....	....
31	W. B. Elliott	26	4	5	1	4	26	3	....	....	....	....
32	H. Schmid	18	4	5	....	....	....	....	....	....	....	100
33	A. C. Newson	21	3	5	....	....	....	....	....	....	....	120
34	C. McCarthy	10	23	3	....	....	3	....	....	....	....	....
35	F. A. Jackson	21	3	5	....	....	....	....	....	....	....	35
36	T. P. McHugh	19	22	4	..	15	50	..	....	....	....	....
37	The Canadian Land and Ranche Co.	12 & 13	23 & 19	3 & 3	....	....	....	....	....	....	....	930
38	A. H. Eckford	18	29	4	....	....	30	....	....	....	....	....
39	Dixon Bros	12	26	3	....	....	....	....	....	....	....	....
40	P. W. King	23	1	5	....	....	60	....	....	....	....	....

the unusual floods experienced in June of that year, caused great damage to irrigation were partially submerged by the overflowing of rivers and creeks and the returns results of irrigation during the past season. The information received has been collected

TIN No. 3.

FROM IRRIGATORS.

Vegetables.	Total.	Number of Irrigations.	Date of Irrigation. First.	Last.	Date of Harvest. Hay.	Grain.	Vegetables.	Remarks.
....	80	2	May	June				
....	180	3	"	"				
1¼	327¼	2	"	"	Aug. to Sept	Aug. & Sept.	October	
1	61	....	....	....	September	Cut green	....	No irrigation owing to floods.
....	156	3	May	Oct.	"	September	....	
....	40	10	"	Aug.	August	....	....	
1½	117½	1	"	....	September	August	October	Oats cut green.
....	35½	2	April	May	....	....	....	Unable to estimate effect of irrigation owing to wet season.
....	40	3	May	June	....	....	....	No details given.
....	....	....	....	....	....	....	....	
2	90	1	May	....	September	September	October	Floods destroyed all but 10 acres
....	60	1	April	....	....	August	....	Wet season, no results from irrigation.
⅔	60½	2	"	June	....	....	....	" "
2	33	1	....	"	September	September	October	" "
11½	108½	4	April	"	"	Aug. & Sept.	Sept	" "
....	60	2	May	....	....	....	....	" "
....	....	....	....	....	....	....	....	" "
....	160	....	....	....	....	....	....	" "
....	14	....	....	....	....	....	....	" "
....	59	3	May	July	July & Sept.	....	....	
3	25	1	"	....	....	September	October	" "
½	22½	1	....	May	September	....	....	" "
....	210	2	May	Oct.	August	....	....	" "
1⅓	1⅓	....	....	....	....	....	October	" "
½	50½	1	....	June	....	....	....	" "
....	32	2	May	....	....	....	....	" "
....	53½	1	....	June	September	September	....	Season too wet for irrigation.
1	11	....	....	....	....	....	....	" "
....	67	1	May	June	....	....	....	
....	135	2	June	July	August	....	....	" "
1	35	....	....	....	Aug. & Sept.	September	....	" "
....	100	1	....	July	August	....	....	
....	120	....	....	....	....	....	....	" "
2	5	1	....	May	....	September	October	
....	35	....	....	....	....	....	....	Irrigation works destroyed by floods.
2	67	2	May	June	....	September	October	
....	930	....	....	....	August	....	....	Wet season, irrigation no needed.
....	30	1	....	May	"	....	....	
4	4	1	April	....	....	....	Sept	
....	60	1	Oct. 1896	....	....	September	....	Land irrigated during the vious fall.

Information from Irrigators.—*Continued.*

Number.	Results. Hay. Tons.	Grain. Bush.	Vegetables. Bush.	General Remarks.
1	80	....	.....	No details given.
2	320	.....	.....	The meadow is improving and producing more hay of good quality. Is looked upon as a success.
3	580	4,300	250	Quality of timothy very fine and excellent feed for horses. Prefer bromus for cattle, being softer and more leafy.
4	....	850	150	Irrigated in the previous fall. Owing to floods field was under water 3 days, and irrigation was not needed.
5	105	600	.....	Light yield of grain owing to late seeding. Timothy and bromus good.
6	35	.....	.....	Slough hay good ; upland hay not so good as previous year.
7	210	....	250	Bromus results satisfactory. 52 acres will be seeded down with bromus during coming season.
8	75	.....	.....	Too much rain to estimate results from irrigation.
9	50	...	...	Water supply in creek runs short too early in the season to make a success.
10	.....	.. ...	.....	No details given. Irrigation works destroyed by floods.
11	23	.....	650	Heavy floods destroyed 32 acres of crop, hence poor results.
12	236	.....	.. ..	Exceptionally wet season interfered with irrigation. A few acres not irrigated only yielded about 1 load per acre.
13	50	...	.....	Exceptionally wet season rendered irrigation unnecessary.
14	60	236	300	" A few acres which were irrigated improved the crop. Consider fall irrigation good for all kinds of hay.
15	106	1,394	766	Exceptionally wet season. Works partly destroyed by floods. Fall irrigation will be tried this season.
16	80	. . .	.....	Exceptionally wet season. No irrigation done.
17	.....	....	.....	" " owing to rain and floods.
18	80	760	... ..	" Hay crop proved a failure owing to heavy irrigation being followed by copious rains.
19	.....	.....	.....	No details given.
20	75	....	.... .	Unable to obtain water when required for irrigation of crop.
21	.....	250	.....	Heavy rains rendered irrigation unnecessary. Garden was irrigated with good results.
22	201	....	.....	All irrigable land was covered by flood during June. 10 tons of clear timothy got from 6 acres of land.
23	25	.....	.....	Most unfavourable season for 6 years, and every crop comparatively a failure. 12 acres of bromus look promising.
24	.....	....	50	Irrigation not practised owing to heavy rains. Garden gave first class results.
25	.....	.....	.....	Unable to cut hay owing to floods. Grass good quality. Vegetables best crop ever grown.
26	48	.....	.....	Bromus made but a poor catch although sown with light crop of oats. Native rye grass yields well but is not relished by stock. Irrigation not needed owing to heavy rains.
27	45	1,079	.....	Good results. Am satisfied of the benefits to be derived from irrigation.
28	25	.....	70	No details given.
29	39	800	.....	Part of timothy cut twice. Green oats also cut twice.
30	105	1,240	.....	Heavy June rains destroyed part of oat crop. 35 acres of timothy gave a splendid return. An excellent crop from garden.
31	71	. ....	.....	Ground well saturated from previous year and June rains rendered irrigation unnecessary. Crop a better average than either of previous two years.
32	100	.....	.....	Ditch not completed until middle of July, and only one irrigation made.
33	80	.....	.....	Land much too wet and cold. Crop about 50 tons less than off same land last year.
34	.....	180	400	No details given.
35	35	.....	.....	Dam destroyed by floods. Plenty of hay from other unirrigated land.
36	125	4,350	300	Ground well soaked the previous fall. Sufficient rains in June and July to render irrigation unnecessary. Straw of crop about 4½ feet long.
37	600	.....	.....	No details given.
38	90	.....	.....	First time water used and found to be a complete success. On land that formely grew nothing I had a heavy crop as the result of irrigation.
39	6	.....	550	Hay made from corn grown on 2 acres of land. 25 acres sown to timothy, alfalfa and bromus, but not irrigated owing to ditch not being constructed as far as that point.
40	180	.....	.....	Shortly after seeding time the strong winds blew out the seed in considerable patches in the field, otherwise I think the yield would have been considerably heavier. The wet and stormy weather in June and July rendered summer irrigation unnecessary.

BULLETIN No. 4

RESULTS FROM

At the close of the year 1898 a form of Bulletin for information regarding irrigation
irrigation would be inserted and the form returned to this office as soon as possible. The
obtained shows that the results have been, generally, successful throughout the Terri-
the crops both of hay, grain and vegetables. The information thus obtained has been

BULLE

INFORMATION

Number.	Name.	Location of Lands.			Acreage Under Crop.									
		Township.	Range.	Meridian.	Wheat.	Barley.	Oats.	Rye.	Timothy.	Alfalfa.	Bromus.	Native Grasses.	Vegetables.	Total.
1	C. W. Peterson	23	1	5	25	5	20	..	5	..	....	50	4	109
2	Canadian Land and Ranche Co.	12 & 13	22	3	..	..	....	..	....	..	....	510	..	510
3	" "	13	19	3	..	..	....	..	....	..	....	319	..	319
4	M. T. Millar	21	3	5	..	..	....	..	....	..	....	25	..	25
5	George Lane & Co	14	29 & 30	4	..	..	....	..	1	..	....	150	1	152
6	A. E. Banister	22	28	4	20	..	10	..	....	..	....	....	1	31
7	F. W. B. George	9	29	4	1	..	21	..	20	..	....	....	..	42
8	J. W. Ockley	22	3	5	..	..	....	15	10	..	25	1	1	52
9	M. Brown	24	1	5	..	..	....	..	....	..	....	....	1	1
10	A. H. Eckford	18	29	4	30	..	....	..	....	..	....	....	2	32
11	J. D. Patterson	22	3	5	..	..	11	10	....	..	1	20	½	42½
12	W. R. Moseley	22	3	5	..	..	10	..	10	..	....	....	..	20
13	A. Lloyd	10	23	3	..	..	12	..	....	..	....	....	..	12
14	W. H. Quail	12	29	4	..	..	25	..	7	..	1½	....	½	34
15	H. St. G. Burn	7	2	5	..	..	....	..	13½	..	....	....	3	16½
16	George Bolt	23	1	5	..	..	15	..	....	..	....	....	..	15
17	H. A. Greeley	10	26	3	4	4	20	..	....	..	12	....	4	44
18	Messrs. Hunter	22	3	5	..	..	....	..	4	..	....	80	..	84
19	Leeds & Elliott	12	28	4	3	..	30	..	5	..	....	....	3	41
20	C. Sharples	12	28	4	..	..	24	..	8	..	....	26	2	60
21	Indian Dept. (Blackfeet Agency)	..	..	..	..	..	60	..	....	..	9½	....	7	76½
22	New Oxley Ranche Co	6	25	4	..	..	128	..	19	..	....	500	..	647
23	P. W. King	23	1	5	..	..	....	..	80	..	....	....	..	80
24	C. O. Card	3	25	4	..	..	....	..	....	..	....	....	..	....
25	J. B. Thibaudeau	5	29	4	..	..	5	..	15	..	....	....	..	20
26	D. Braniff	11	23	3	..	..	....	..	....	..	....	....	..	....
27	John Furman	1	26	4	..	7	18	..	25	..	½	....	¼	50¾
28	H. Schmid	18	4	5	..	..	....	..	....	..	....	100	..	100
29	R. Turner	21	3	5	..	..	....	..	....	..	....	60	..	60
30	G. Anderson, jr	21	3	5	..	..	2	..	....	..	....	73	..	75
31	" sr	21	3	5	..	..	....	..	....	..	....	15	..	15
32	Jas. McCormick	11	23	3	..	..	9	..	....	..	....	....	½	9½
33	Hull Bros. & Co	22	1	5	..	25	160	..	135	..	115	35	..	470
34	T. P. McHugh	19	23	4	75	20	50	..	....	..	....	....	5	150
35	Mrs. Annie Dowling	22	3	5	..	9	8	..	10	..	....	....	1	28
36	W. Moore	10	25	3	..	..	10	..	....	..	....	40	..	50
37	D. H. Pollock	7	21	3	..	..	....	..	....	..	....	60	2	62
38	H. C. Lawson	21	19	2	..	..	....	..	....	..	....	....	..	....
39	W. E. Austin	20	1	5	..	..	10	..	....	..	....	30	..	40
40	A. T. Wallace	18	24	3	2	2	6	..	....	..	....	....	..	10
41	Dixon Bros	10	26	3	..	..	2	..	10	..	35	....	..	47
42	A. E. Cross	16	1	5	..	..	....	..	....	..	3	....	1	4
43	J. L. Johnston	21	22	4	..	..	55	..	....	..	....	....	..	55
44	A. A'Lindquist	1	26	4	..	..	....	..	30	..	....	....	¾	30¾
45	Joseph Fisher	21	2 & 3	5	..	..	....	..	....	..	....	200	..	200

was prepared and forwarded to each irrigator with a request that the results obtained from greater number of irrigators responded to this request, and the information thus tories, whilst in several instances it has been proved that irrigation has largely increased condensed and the following statement compiled, and issued as

TIN No. 4.

FROM IRRIGATORS.

Number of Irrigations.	Date of Irrigations.		Date of Harvest.			Remarks.
	First.	Last.	Hay.	Grain.	Vegetables.	
2						
1						
1						
2	May	August	September			
2	"	September				
				September		Land was irrigated the previous fall.
1		June	July	Aug. & Sept.		
1	June					Timothy irrigated continuously for 3 weeks.
2	July	July				
2	June	"		August	October	Wheat and oats a mixed crop.
2	Previous fall	"	August	Aug. & Sept.		
2	May	"	July	August		
2	June	"		"		
1	"					
2	May	October	July		October	
3	July	August	September			
				August	October	
2	June	July	August			
2	Previous fall	August	August	September		
8	May	July				
2						
1	June		July			
2	"	July				Irrigated lands are in gardens in Village of Cardston.
1	July					
						No details given.
2	May	July	July	September		
2	May	June				
			September	August		Ditch was destroyed and no irrigations made.
			"			" "
			"			Creek overflowed, and rendered irrigation unnecessary.
3	Not stated.	Not stated.	July & Aug.			
2	Spring	Fall	September			
1	July					
1	June		September	September		
2	May	October	October			
						This year cut, 375 loads of hay from native grasses—Great increase over previous year.
2	May	August	September	August		
						Cut green for seed.
		June	July			
3	May	July	August			
						Dam broke and irrigation impossible.
			September		October	
3	May	July				Results very successful.

Information from Irrigators.—*Continued.*

Number.	Results. Hay. Tons.	Grain. Bush.	Vegetables. Bush.	General Remarks.
1	95	1,025	300	Water supply very erratic. Garden properly irrigated and good results were most
2	660	....	.....	No further details given. [astonishing.
3	321	"	"	
4	30	.....	.....	Ditch damaged by floods otherwise more land would have been irrigated.
5	150	.....	.....	Irrigation proved a success with me. Don't think any one can make a mistake if they use water rightly.
6	60	820	.....	Results very satisfactory. Garden yielded best all round crop I ever grew.
7	87	.....	.....	Timothy was a light crop, but was not irrigated early enough. Second crop from rye grasses, both good for hay and well worth cultivating, stock like these grasses well. Consider fall irrigation better for grain.
8	93	30	.....	Experimented with one acre of wheat and had good success. Oat yield magnificent, and straw 5 feet high. Had excellent results from all lands irrigated. Find fall irrigation best.
9	.....	.....	.....	Water only used on garden. Planted 270 trees and only lost 2. Have several times tried to grow trees without irrigation, but failed.
10	150	545	200	Light soil and requires constant watering.
11	58	633	.....	Potatoes were badly frozen. Consider it better to irrigate cultivated land in the fall.
12	50	.....	.....	Oats badly frozen early in June.
13	.....	450	.....	Fifteen loads of straw obtained.
14	6	.....	100	About 75 tons of oat straw obtained. Garden crop good.
15	16	.....	.....	Timothy not irrigated early enough. Potatoes gave a very large yield. Garden crop
16	60	.....	.....	Oats cut green, only about two-thirds of crop irrigated. [good.
17	21	.....	....	Hot dry winds in July nearly ruined crop. Found that where water ran freely on prairie sod a good crop of blue joint grass sprung up, shall pay some attention to this matter.
18	128	.. .	.....	All irrigated lands are black topped and heavy. Were well pleased with results and approve of irrigation.
19	7	836	.....	Ditch not in working order.
20	16	1,458	.....	Cut some very fine native grass raised entirely by irrigation, for years previously the land was bare of grass.
21	27	2,522	320	Main canal only completed this year and unable to have a satisfactory test. Potatoes and garden truck were eaten during the growing season.
22	296	.....	.....	Bromus was sown with the oats but made little showing during the year. Ditch broke during the spring and 77 acres of oats did not get enough water.
23	90	.....	.....	First cutting after seeding, average length about 30 inches.
24	.....	.....	.....	All vegetables did well and were greatly aided by irrigation. Turnips and roots yielded from 200 to 500 bushels per acre, and potatoes from 100 to 200 bushels per acre.
25	25	. ...	.....	Only necessary to irrigate once, owing to very wet season.
26	84	815	290	Very heavy hay crop where freely irrigated. Wheat was destroyed by hail.
27	35	1,000	67	Irrigated land is of five-fold value, safe with water, unsafe without. Oats weighed
28	.....	.....	... ..	No details given. [40 to 43 lbs. per bushel.
29	60	.....	.....	"
30	66	. ...	.....	Dam destroyed by flood the previous year, and ditch filled up. Could not get water for irrigation when needed.
31	15	.....	.....	Dam destroyed by flood the previous year, and ditch filled up. Could not get water for irrigation when needed.
32	.. .	540	90	No irrigation done, land was covered with water by over flowing of creek.
33	420	... ..	.....	A great portion of timothy and bromus was sown 5 years ago, consequently results are not so satisfactory. Too much water is liable to kill bromus. Garden crop was exceptionally good.
34	.....	2,600	1,400	Irrigating in the fall and again the following spring ensures a crop. Garden crop was the finest I have ever grown.
35	75	.....	.....	Barley and oats cut green.
36	65	.....	.....	Oats irrigated once. Native grasses first watered in May and had two waterings afterwards.
37	.....	.....	.....	Did not get very good returns, the grass thickened but did not grow to any length. Potatoes did well, but I kept no record of the number of bushels.
38	375	.....	.....	Irrigated a hay meadow of native grasses. Cut 375 tons of hay this year, where previously only 175 tons have been cut. The outlet ditch broke before I wanted to let the water off, or I could have cut more hay.
39	45	.....	.....	Water was applied to native grasses about ten times during the season.
40	14	.....	.....	Cereals cut green for feed.
41	60	.....	.....	Timothy and alfalfa was very thin and not worth cutting.
42	4	.....	350	Results very satisfactory.
43	125	.....	.....	Dam broke in spring and was not repaired.
44	40	.....	83	No details given.
5	300	.....	.....	Parts of the meadow were regularly irrigated at intervals, and the crop was the best return I have ever had since I began to irrigate.



PLATE I.—ING'S FLAT ON HIGHWOOD RIVER, WHERE BASE WAS MEASURED.

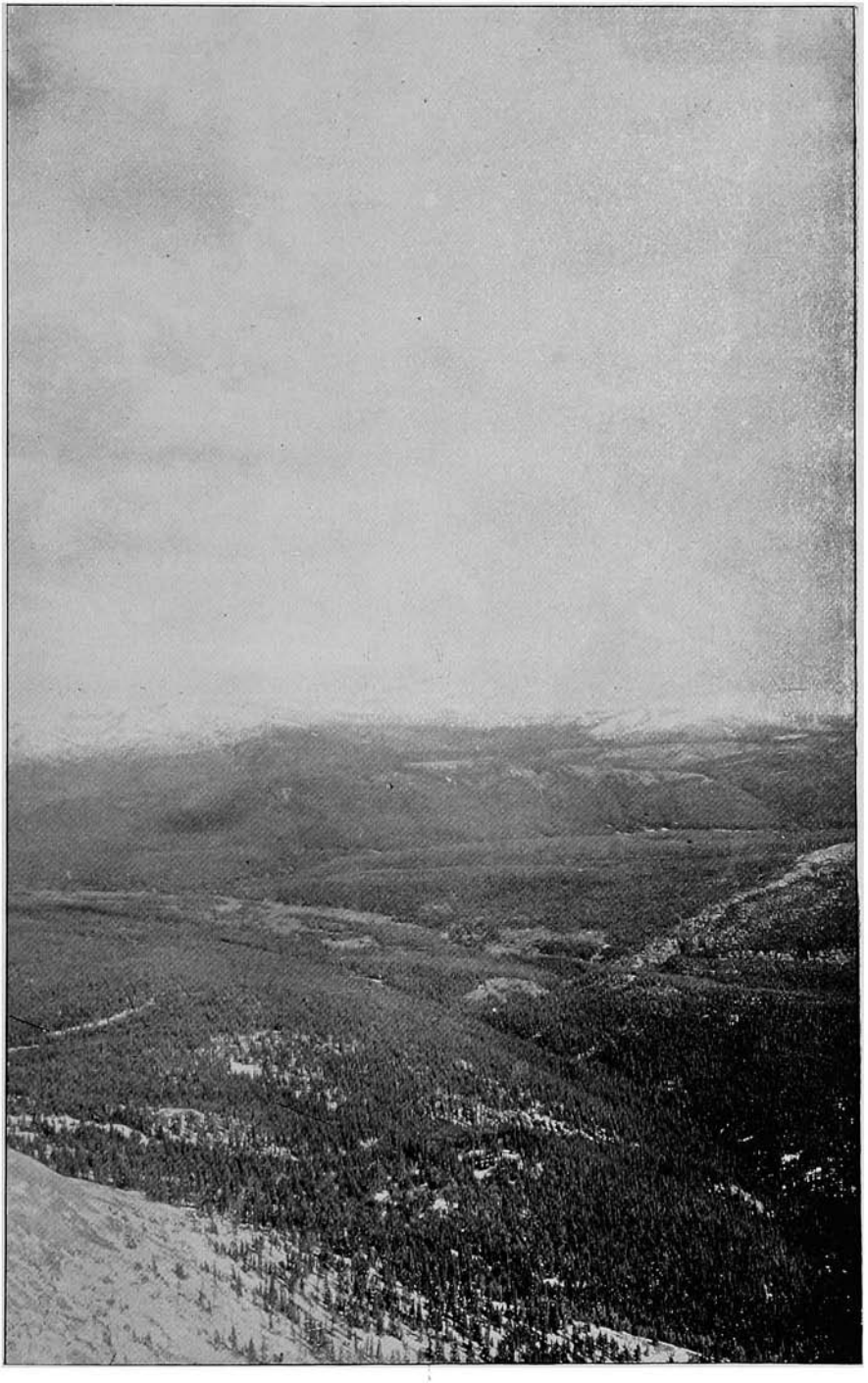


PLATE II.—SHOWING TIMBER DISTRIBUTION IN THE CROW NEST TROUGH.

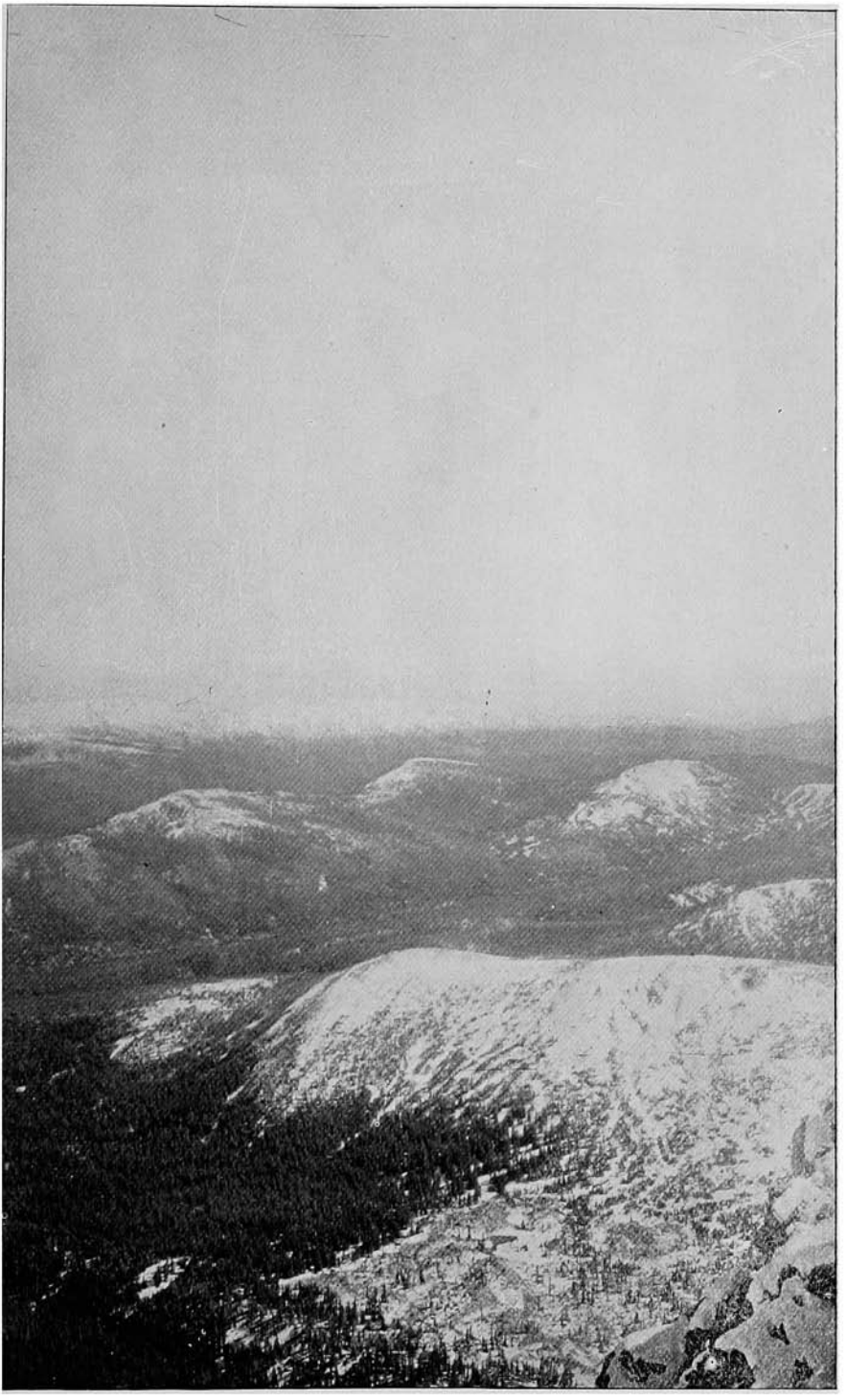


PLATE III.—SHOWING TIMBER DISTRIBUTION IN THE CROW NEST TROUGH.



PLATE IV.—AMPHITHEATRE AT THE HEAD OF LIVINGSTONE RIVER.

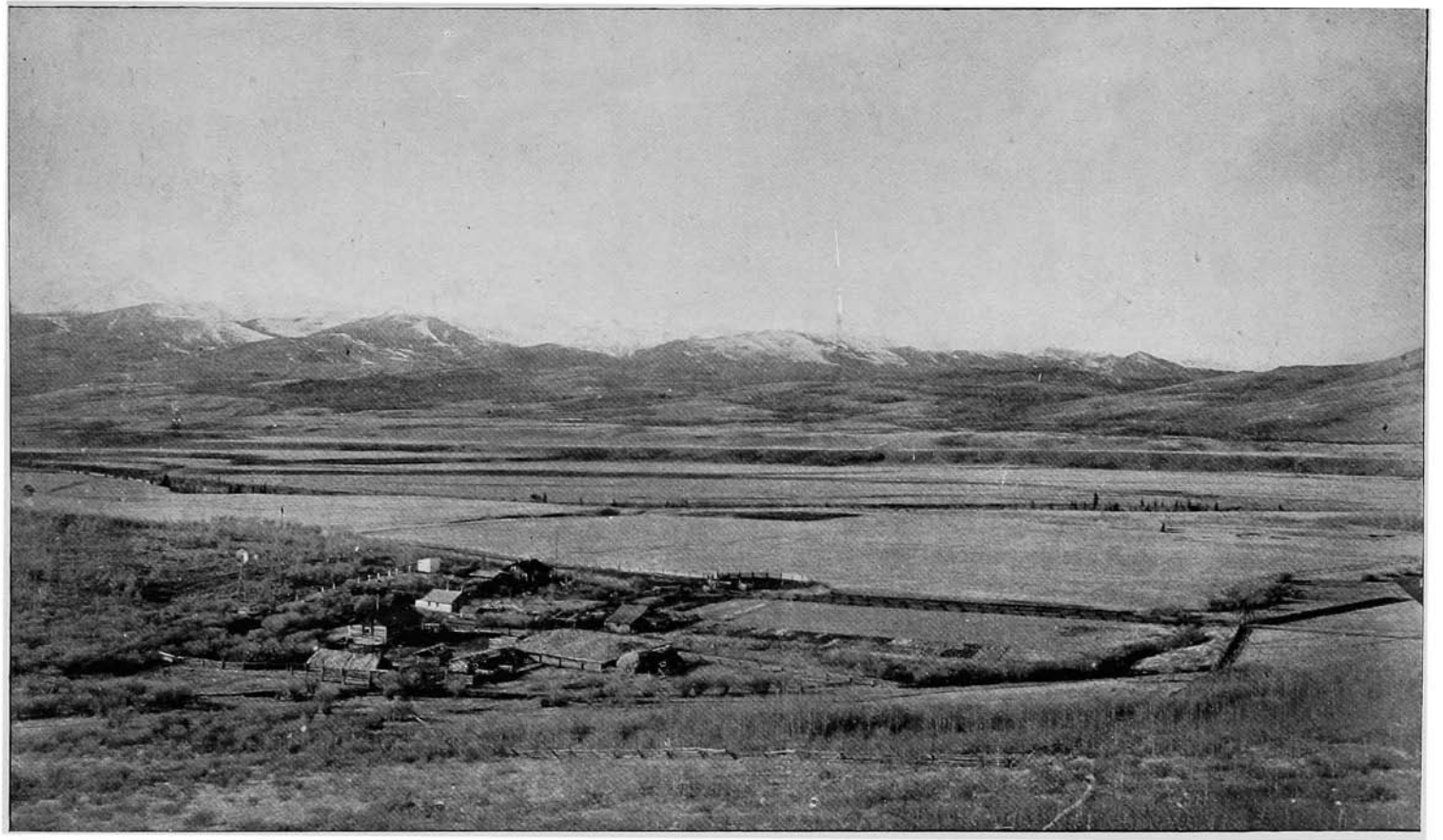
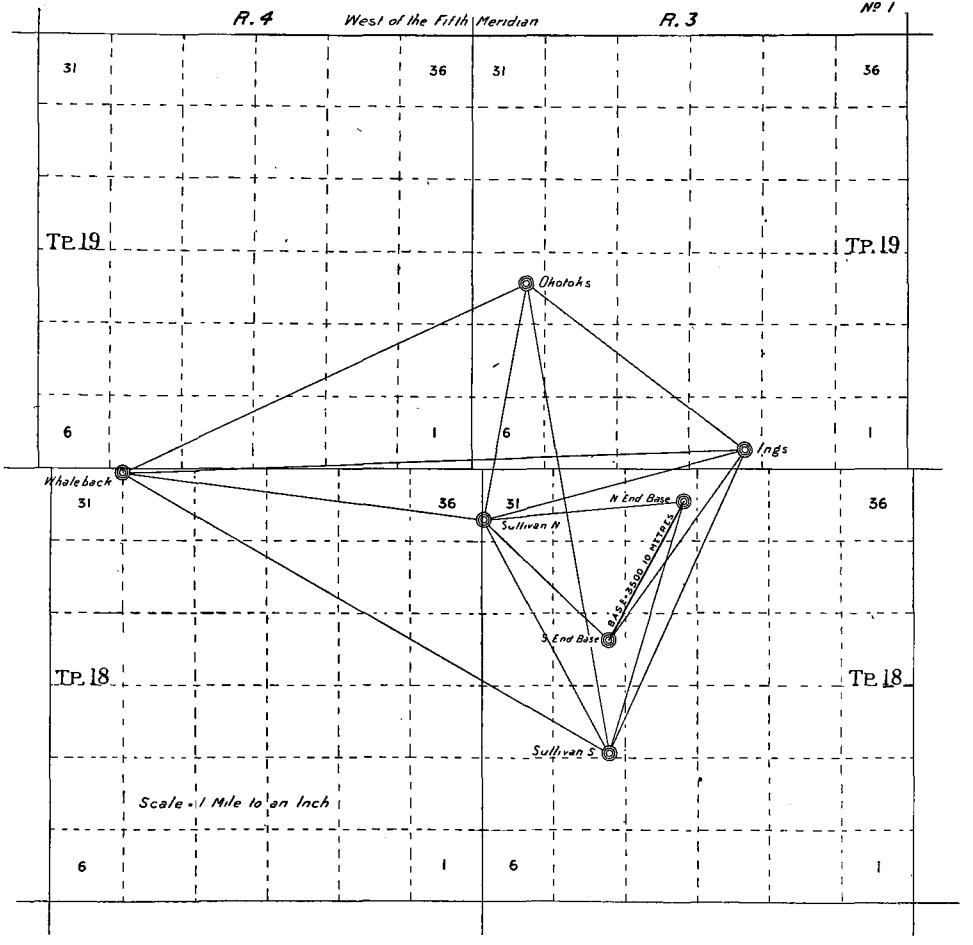


PLATE V.—PFLUGHAUPT'S RANCH ON HIGHWOOD RIVER.

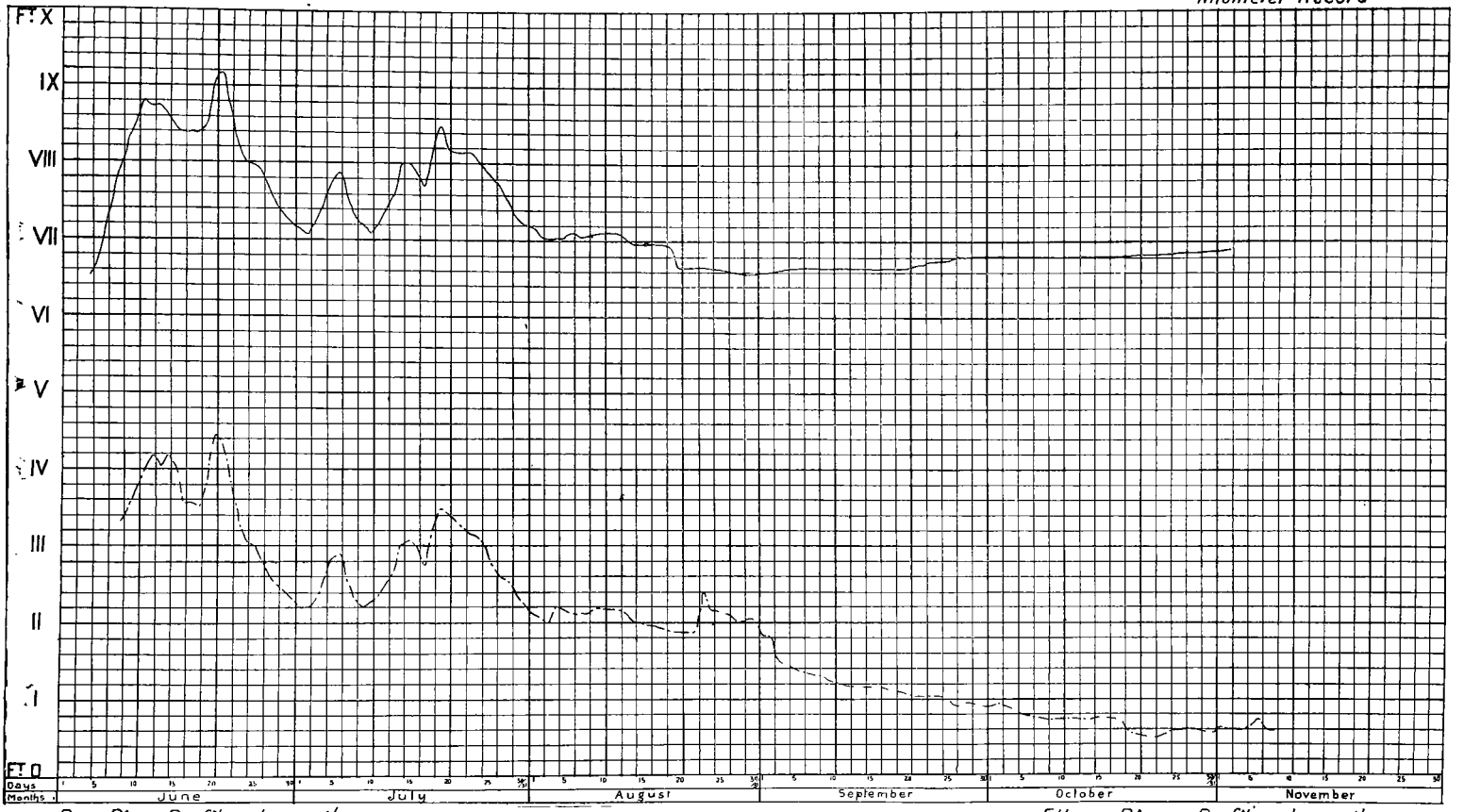


Showing Expansion from Base in Ings Flat on North Side of Highwood River

Diagram Showing Rise and Fall of Bow and Elbow Rivers 1898

Nilometer Record No 2

13—vii—11½



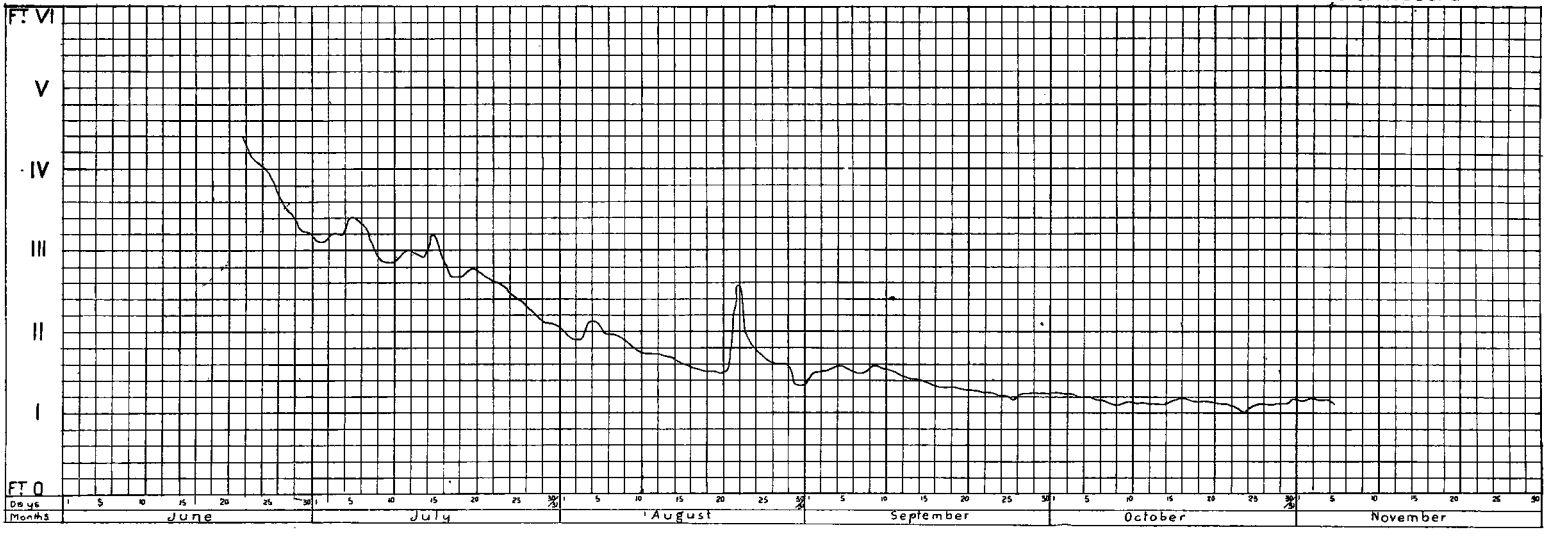
Bow River Profile shown thus ~

Elbow River Profile shown thus - - -

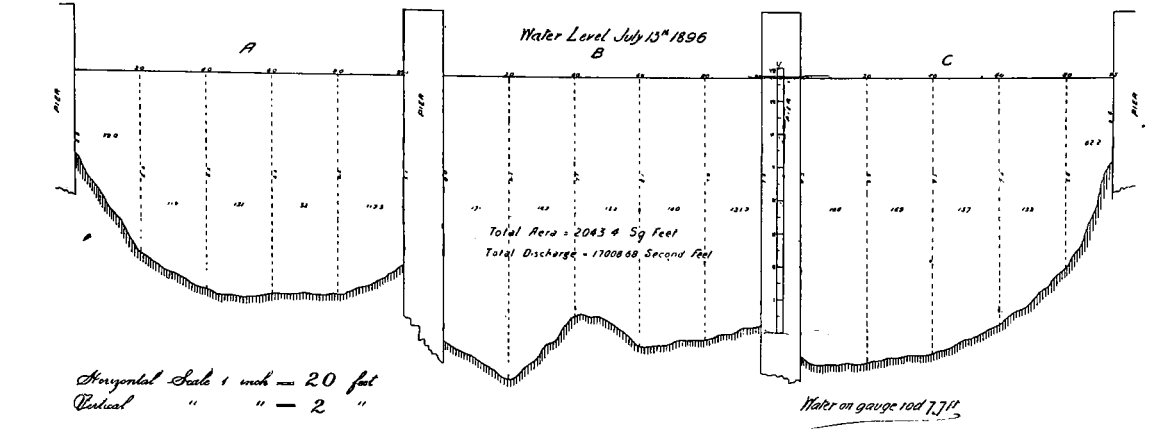
Diagram Showing Rise and Fall of High River 1898

Nilometer Record.

No 3



Cross-Section of Bow River at Langevin Bridge, Calgary showing change in two years



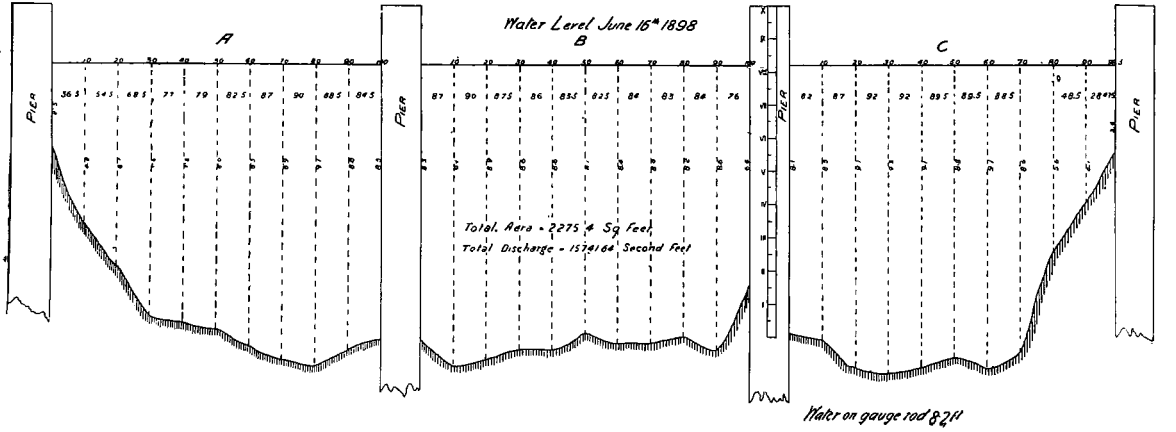


Figure I

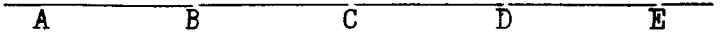


Figure II

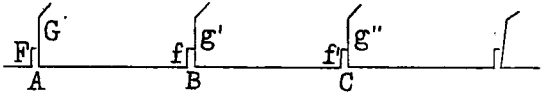


Figure III

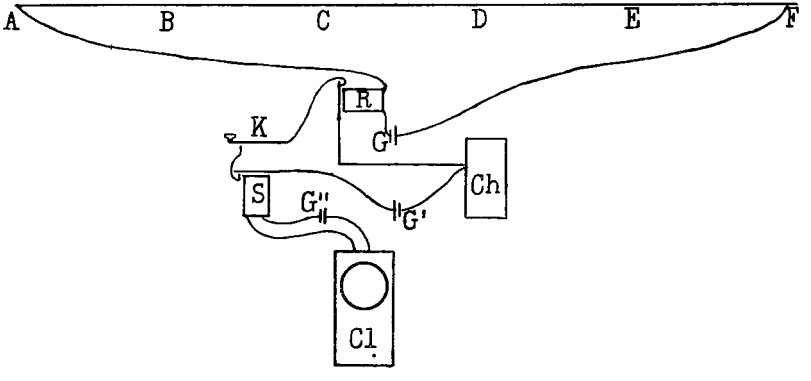


Figure IV

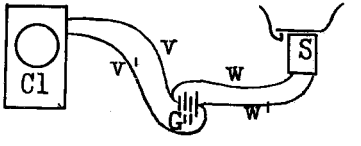
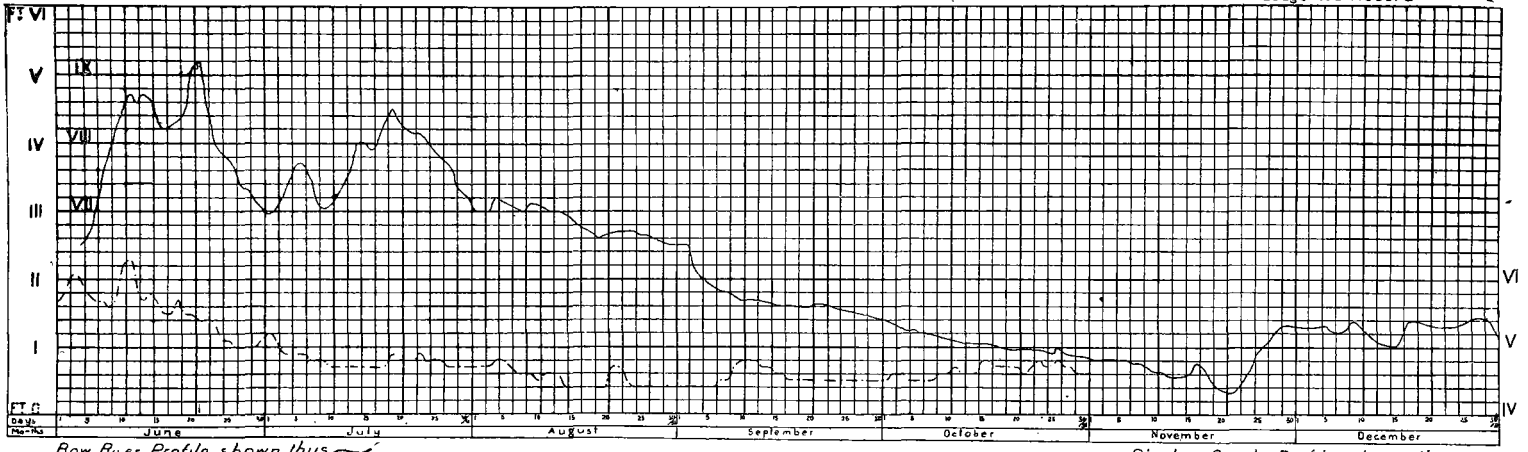


Diagram Showing Rise and Fall of Bow River and Pincher Creek 1898

Gauge Rod Record No 6



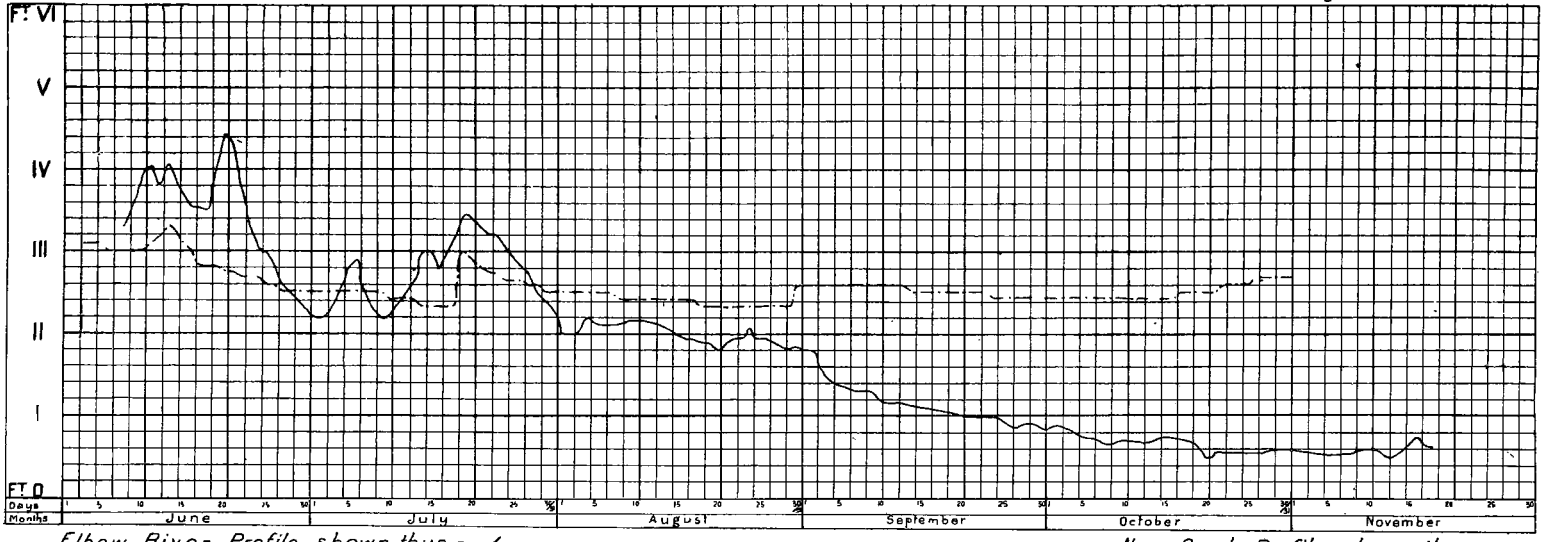
Bow River Profile shown thus ~

Pincher Creek Profile shown thus -.-

DIAGRAM SHOWING RISE AND FALL OF ELBOW RIVER AND NOSE CREEK 1898

Gauge Rod Record

No 7



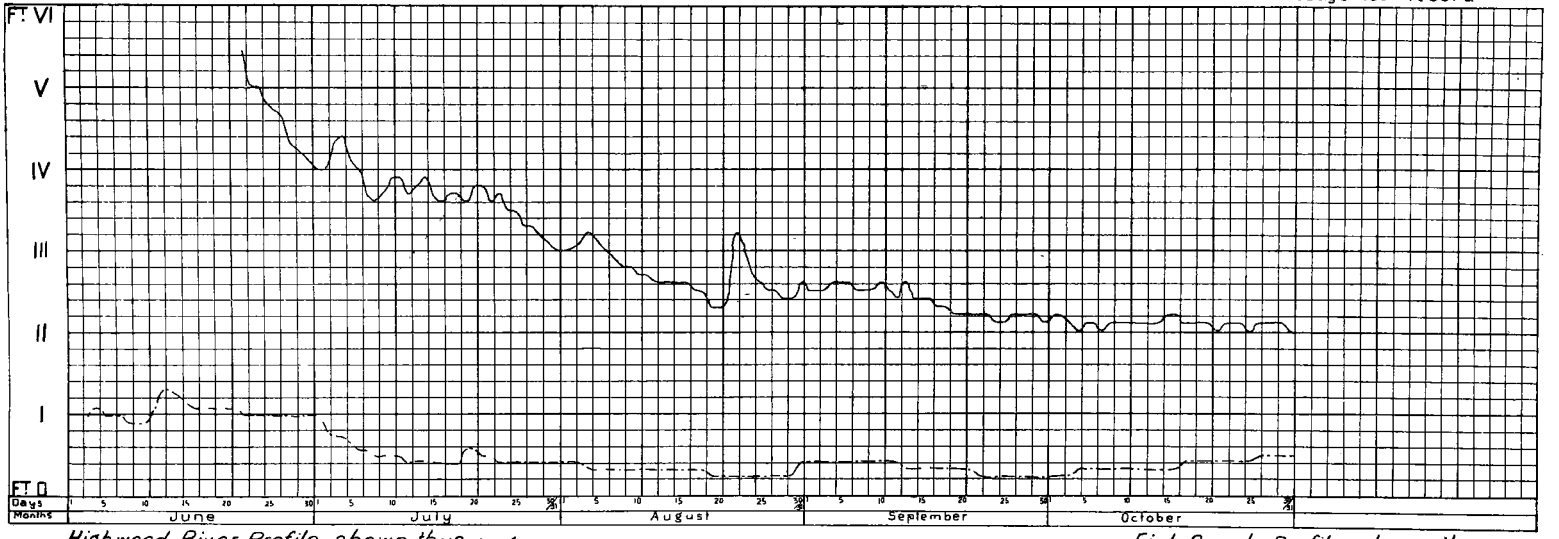
Elbow River Profile shown thus ~

Nose Creek Profile shown thus -.-.

Diagram Showing Rise and Fall of Highwood River and Fish Creek 1898

Gauge Rod Record

№ 8

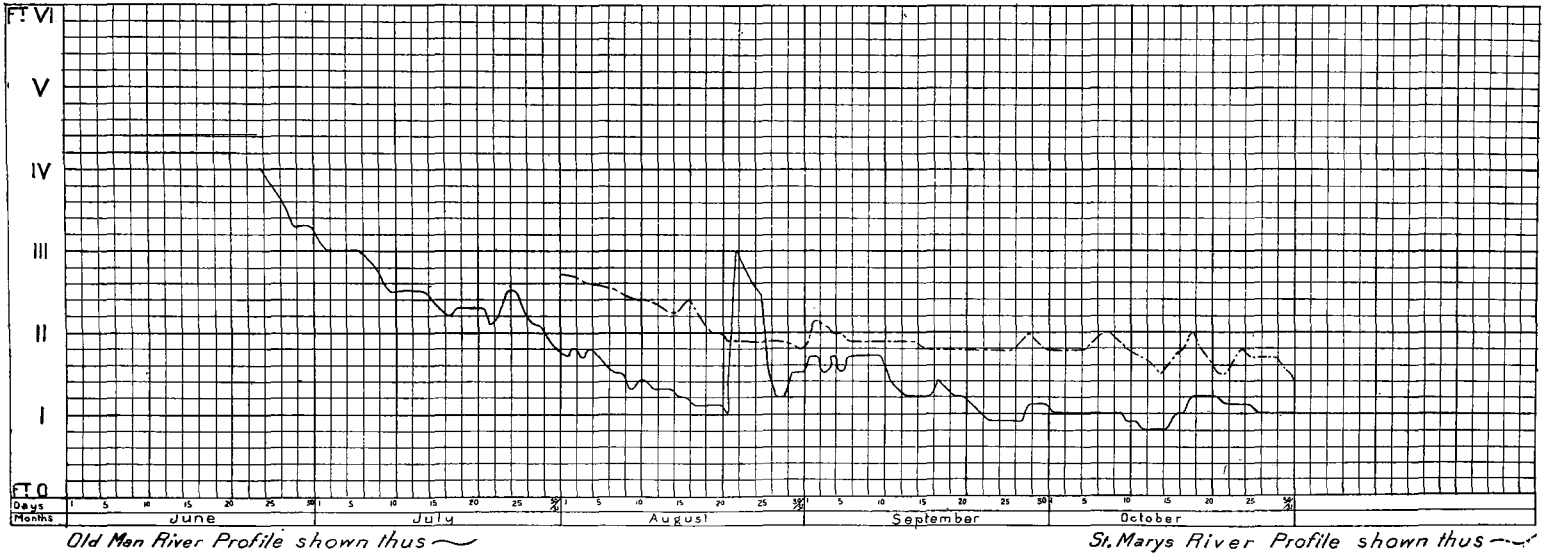


Highwood River Profile shown thus ~

Fish Creek Profile shown thus -.-

DIAGRAM SHOWING RISE AND FALL OF OLD MAN AND ST. MARYS RIVERS 1898

№ 9

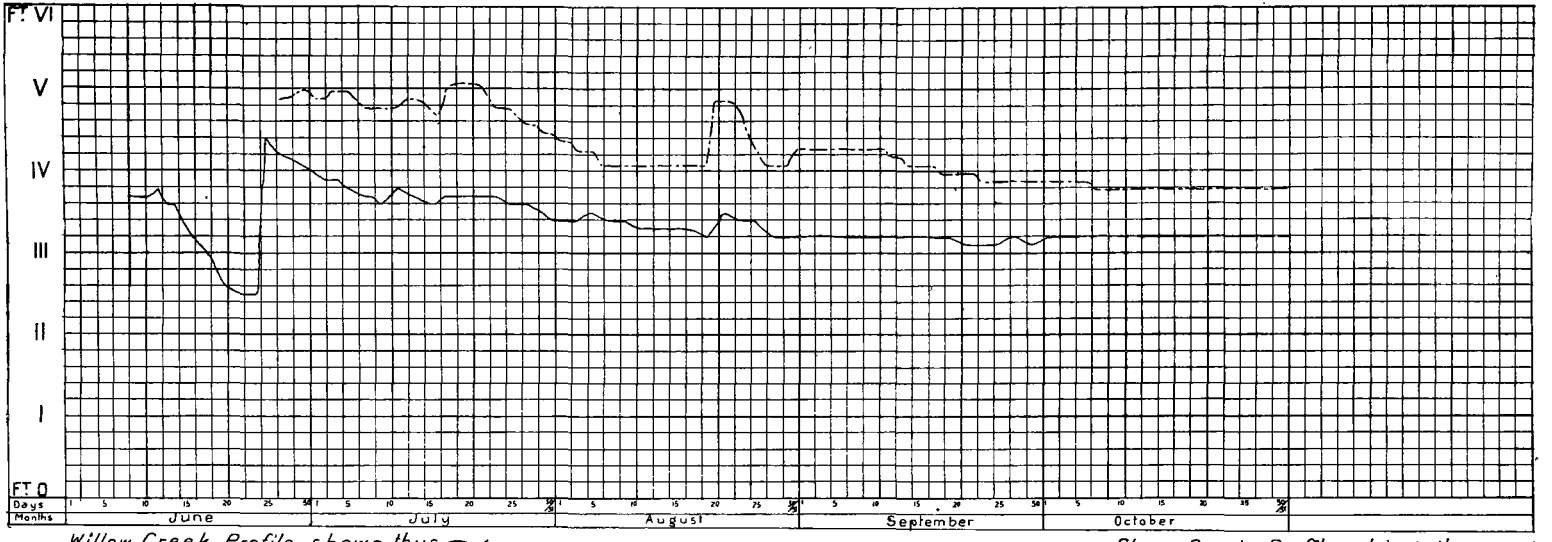


Old Man River Profile shown thus ~

St. Marys River Profile shown thus -.-

Diagram Showing Rise and Fall of Willow and Sheep Creeks 1898

No 10



Willow Creek Profile shown thus ~~

Sheep Creek Profile shown thus - - -

Diagram Showing Rise and Fall of North and South Forks of Mosquito Creek 1898

No 11

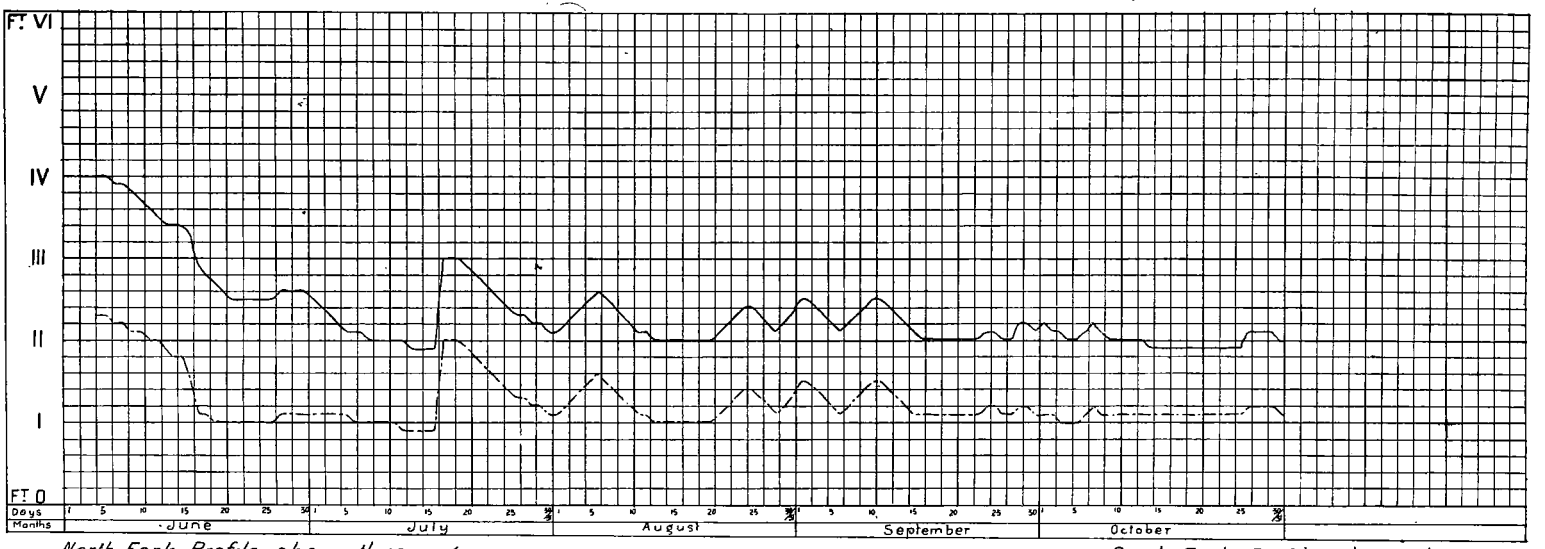
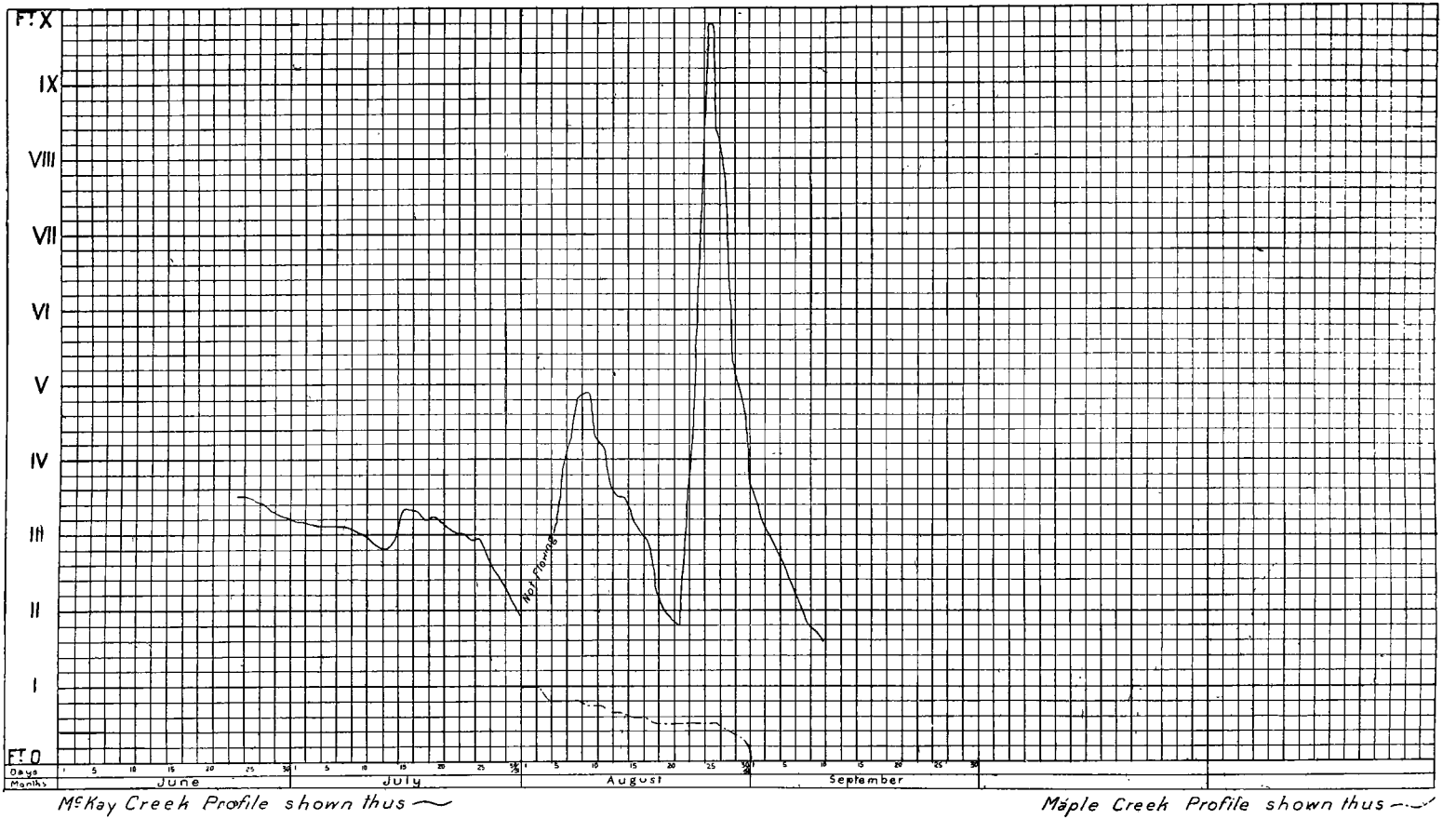


Diagram Showing Rise and Fall of McKay and Maple Creeks 1898

No 12

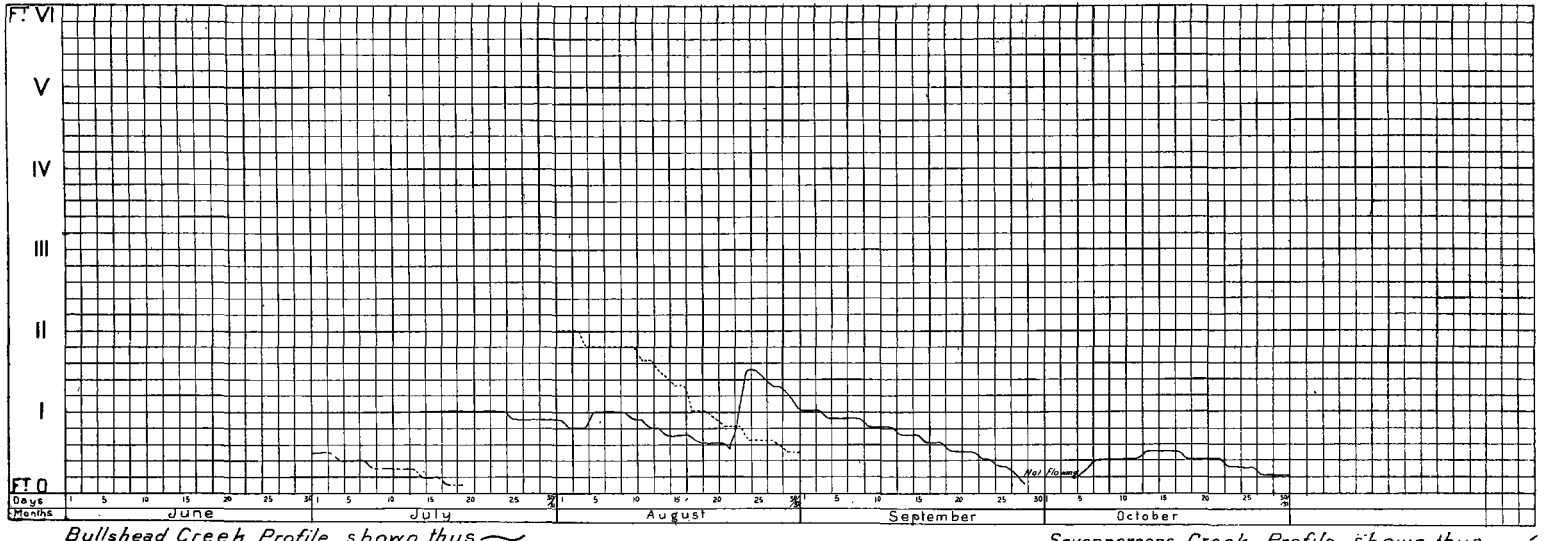


McKay Creek Profile shown thus ~

Maple Creek Profile shown thus -.-

Diagram Showing Rise and Fall of Bullshead and Sevenpersons Creeks 1898

No 13



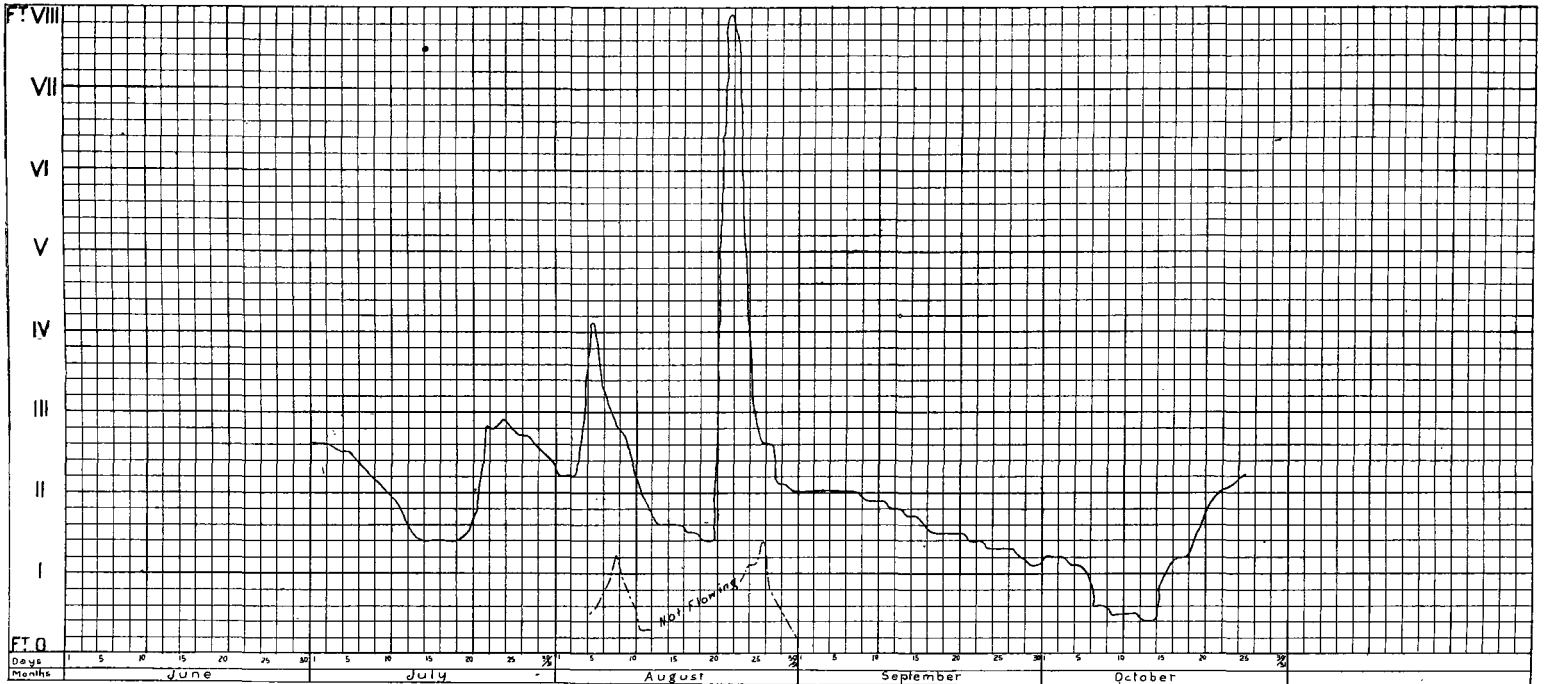
Bullshead Creek Profile shown thus ~~~

Sevenpersons Creek Profile shown thus -·-·-

Rise and Fall of Fish Creek Shown Thus .....

Diagram Showing Rise and Fall of Ross and Boxelder Creeks 1898

No 14

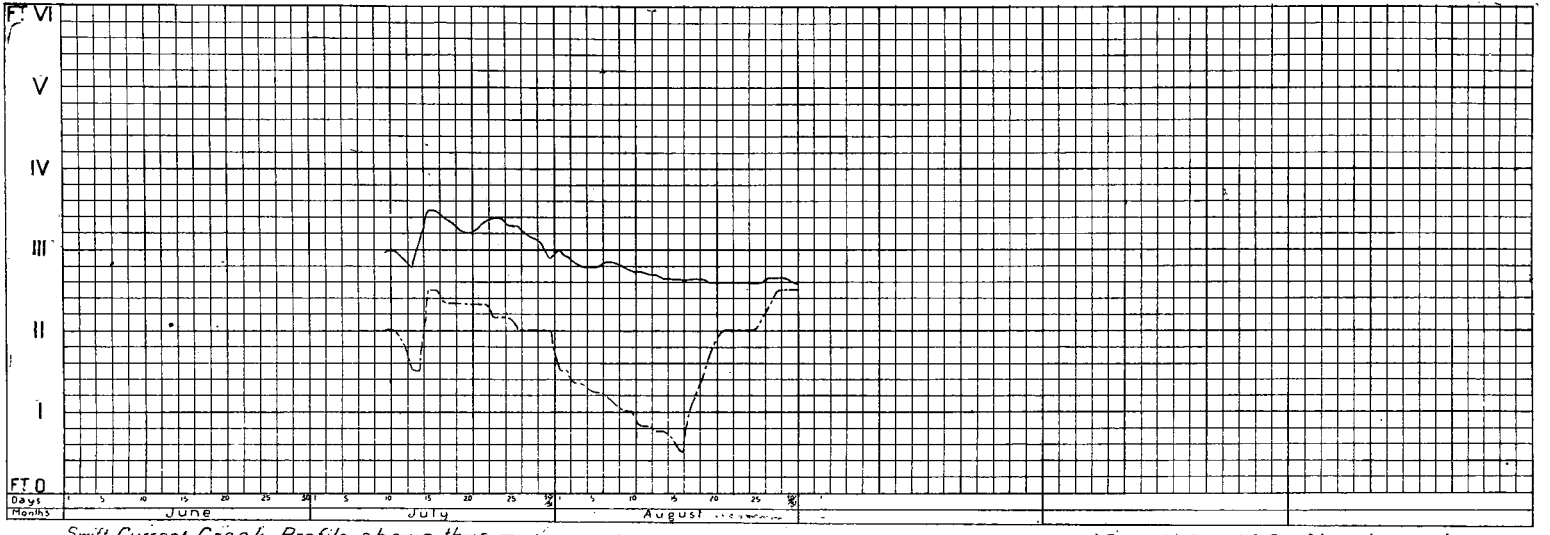


Ross Creek Profile shown thus ~

Boxelder Creek Profile shown thus -.-

Diagram Showing Rise and Fall of Swift Current and Piapot Creeks 1898

No 15



Swift Current Creek Profile shown thus ~

Piapot Creek Profile shown thus -.-

a.a.

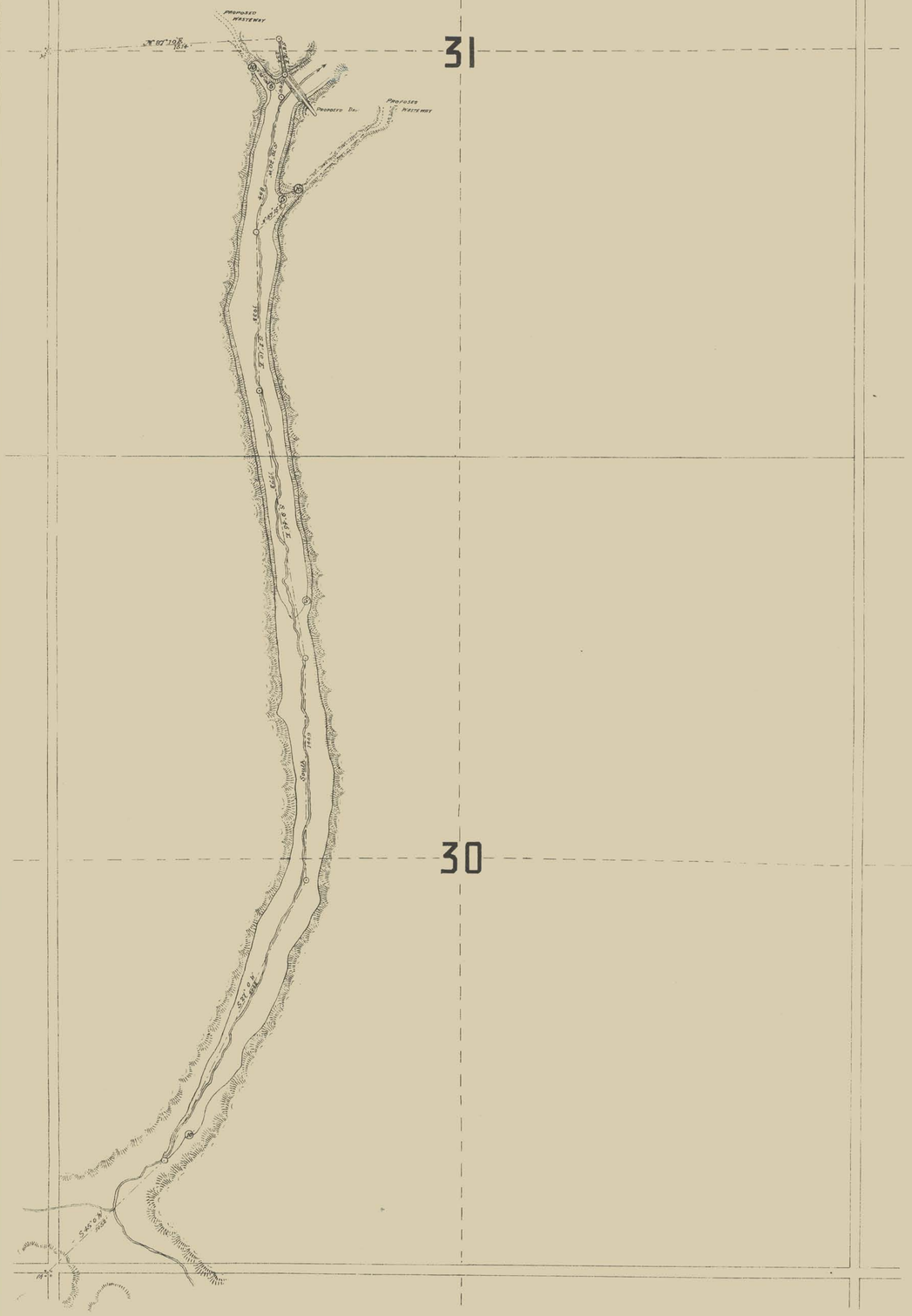
— CANADIAN IRRIGATION SURVEYS —

— PARTY Nº 3. —

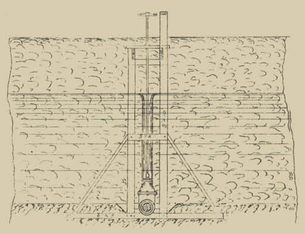
— PLAN OF DAM AND RESERVOIR —

— IN SECS. 30 & 31, TP. 16, RGE. 6, W. 2ND M. —

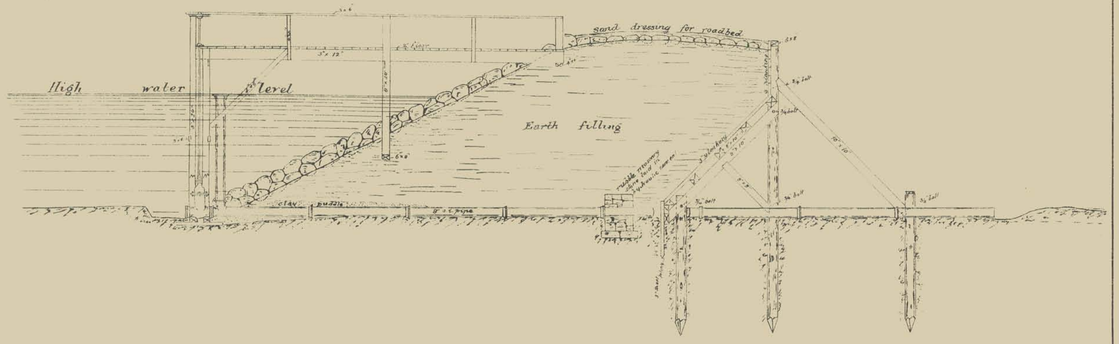
Arthur O. Wheeler.
In charge of Irrigation Surveys
Calgary. May 1st 1899



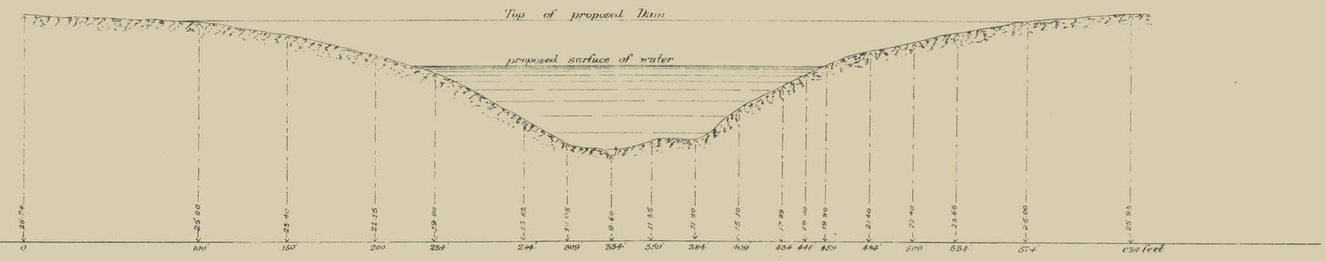
— GENERAL PLAN —
SCALE 500 FT = 1 INCH



— Front Elevation of Sluice —



— SECTION OF DAM —
SCALE 8 FT = 1 INCH



— PROFILE OF DAM —
HORIZONTAL SCALE 50 FT = 1 INCH
VERTICAL " 10 " "

Surveys and plans by J T Child C.E.

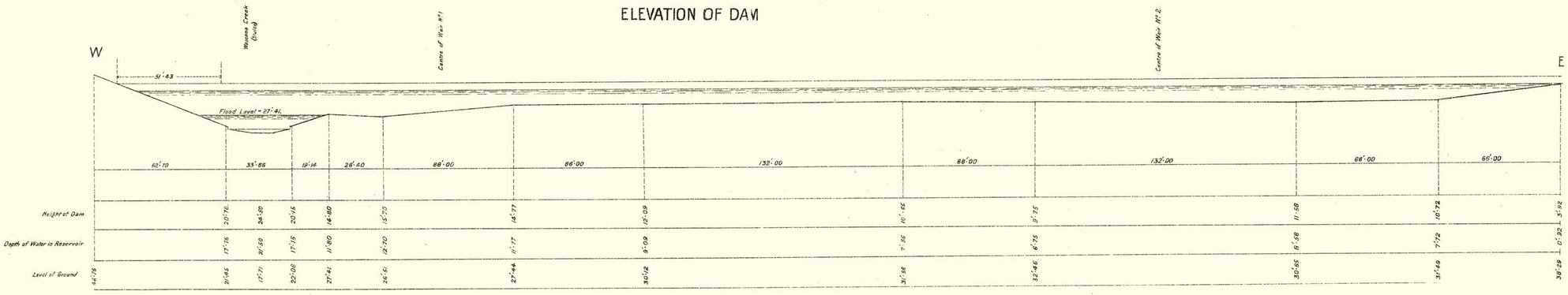
CANADIAN IRRIGATION SURVEYS

SUB-PARTY Nº 2 1897

ELEVATION AND PLAN OF DAM ON WASCANA CREEK

Tp 18 – R 21 — W of 2 M^N

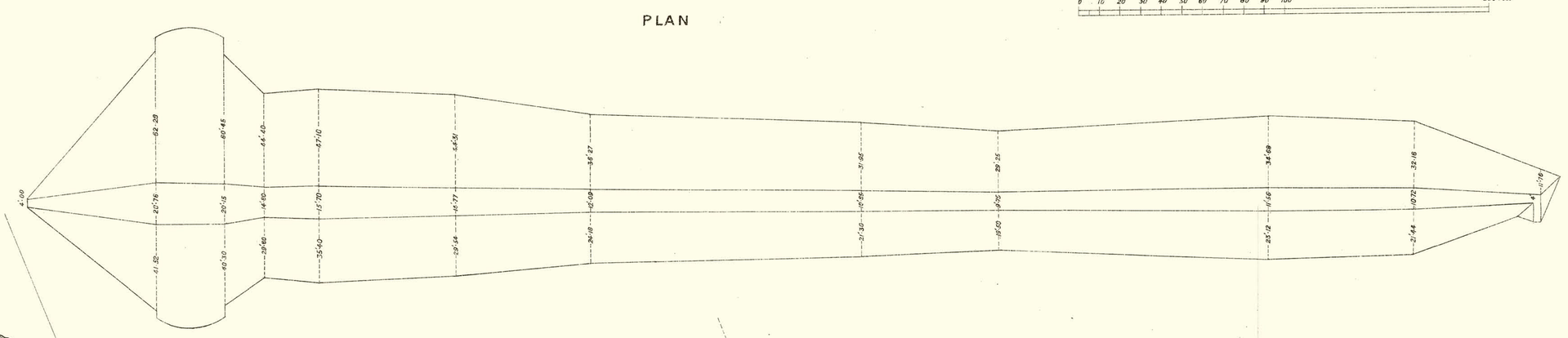
ELEVATION OF DAM

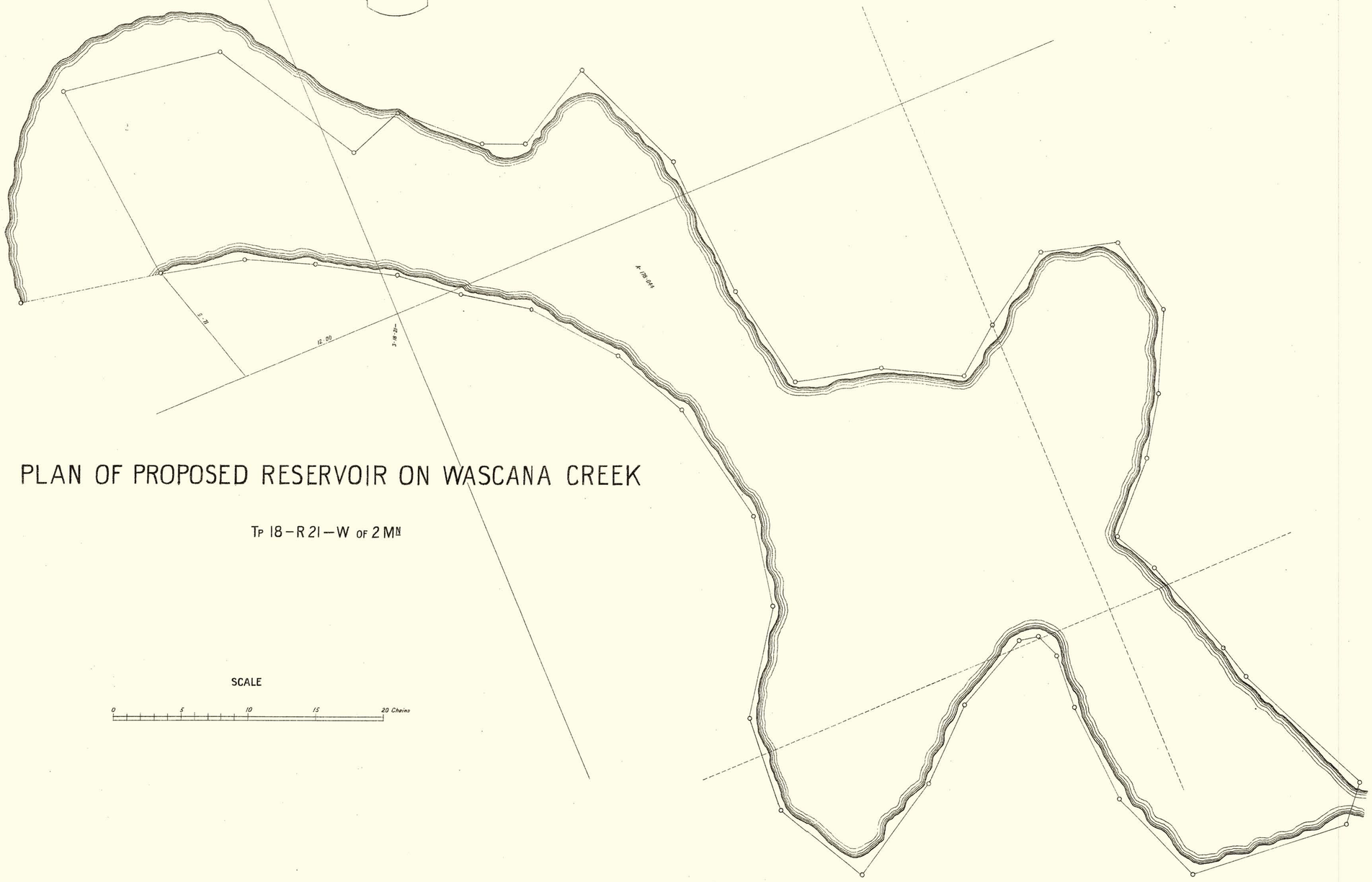


SCALE

0 10 20 30 40 50 60 70 80 90 100 200 Feet

PLAN





PLAN OF PROPOSED RESERVOIR ON WASCANA CREEK

Tp 18 – R 21 – W of 2 M^N

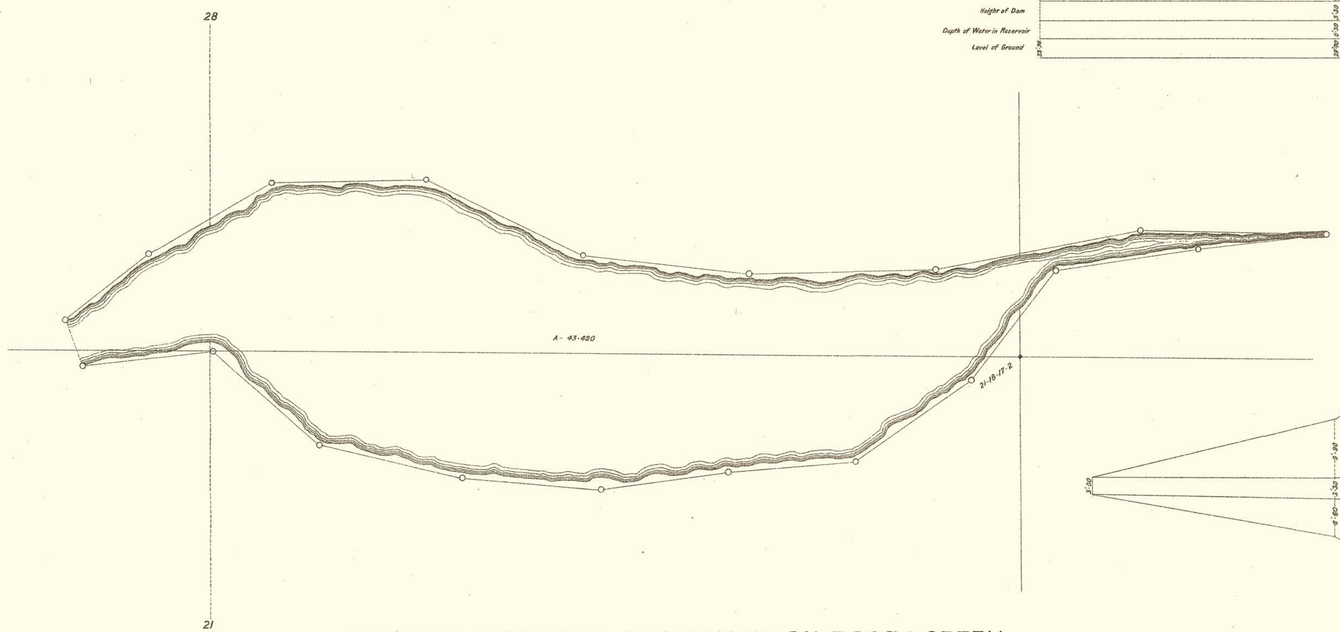
SCALE

0 5 10 15 20 Chains

Surveys and Plans by O. Yorke C.E.

—CANADIAN IRRIGATION SURVEYS.—

—SUB-PARTY Nº 2-1897.—



PLAN OF PROPOSED RESERVOIR ON BOGGY CREEK.

Tp 18 R. 17 — W. of 2 Mn.

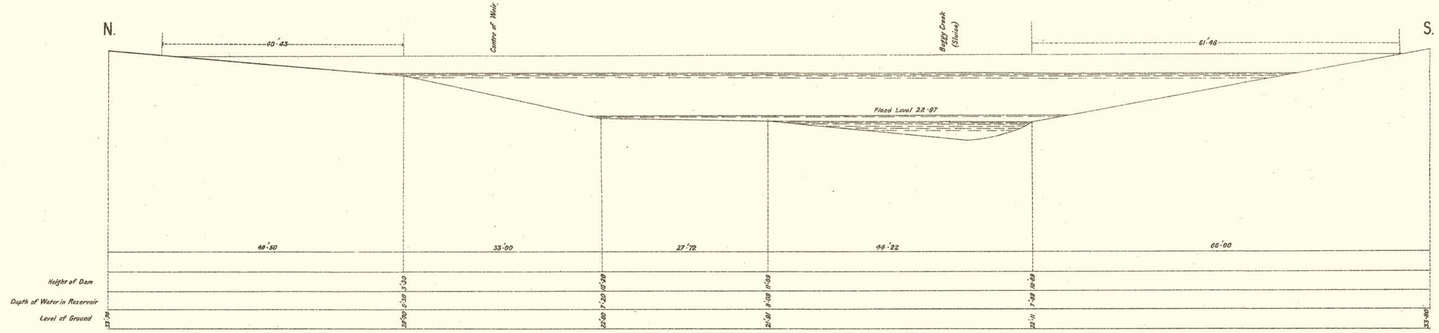
SCALE.

0 5 10 15 20 Chains

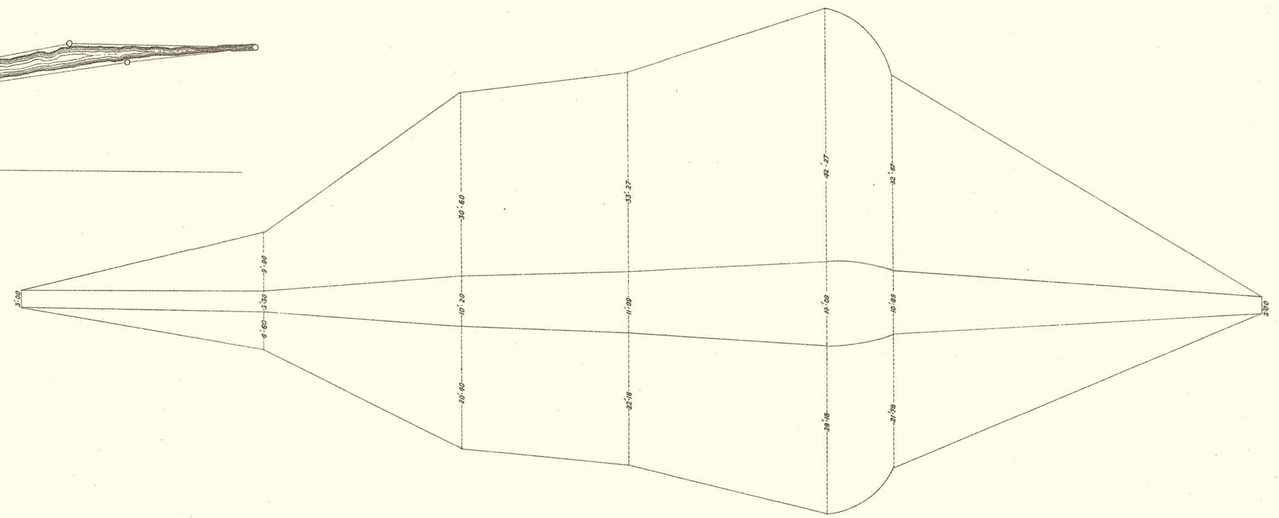
ELEVATION AND PLAN OF DAM ON BOGGY CREEK

Tp. 18 - R17 — W. of 2 Mn.

ELEVATION OF DAM.



PLAN



SCALE

0 10 20 30 40 50 Feet

Surveys and Plans by O. Yorke C.E.

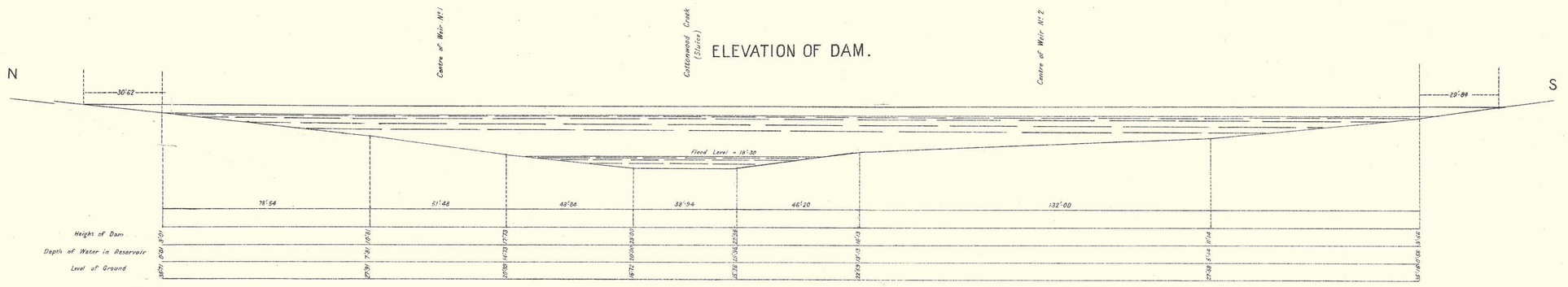
CANADIAN IRRIGATION SURVEYS

SUB-PARTY Nº 2-1897

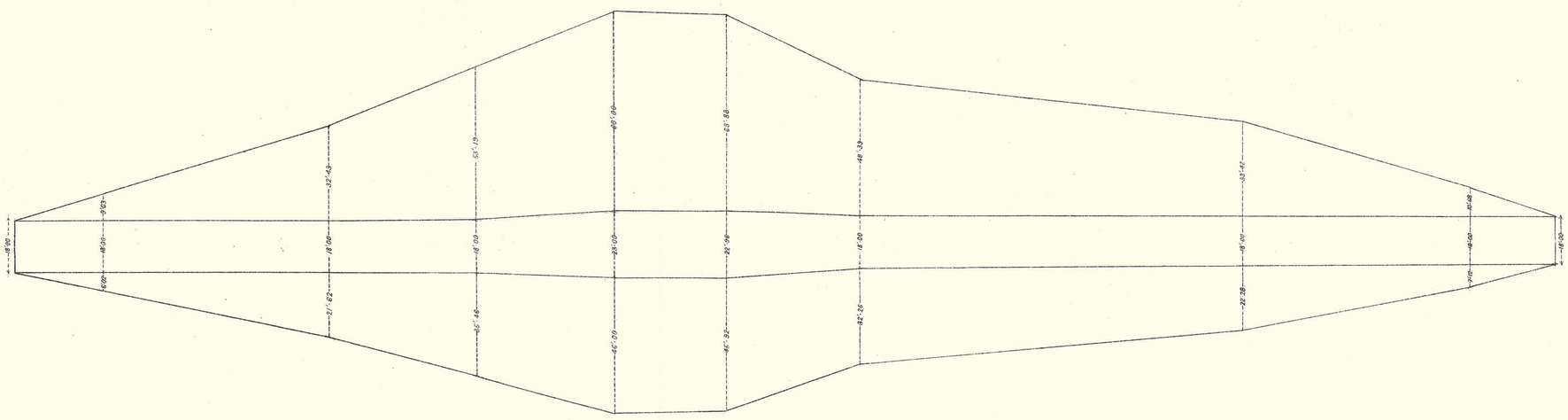
ELEVATION AND PLAN OF DAM ON COTTONWOOD CREEK

Tp 17-R 22 — W of 2 Mn.

ELEVATION OF DAM.



PLAN.



SCALE

0 5 10 20 30 40 50 100 Feet

PLAN OF PROPOSED RESERVOIR ON COTTONWOOD CREEK

Tp 17-R 22 — W of 2 Mn.



SCALE

5 10 20 Chains

Surveys and Plans by O. Yorke, C.E.

CANADIAN IRRIGATION SURVEYS.

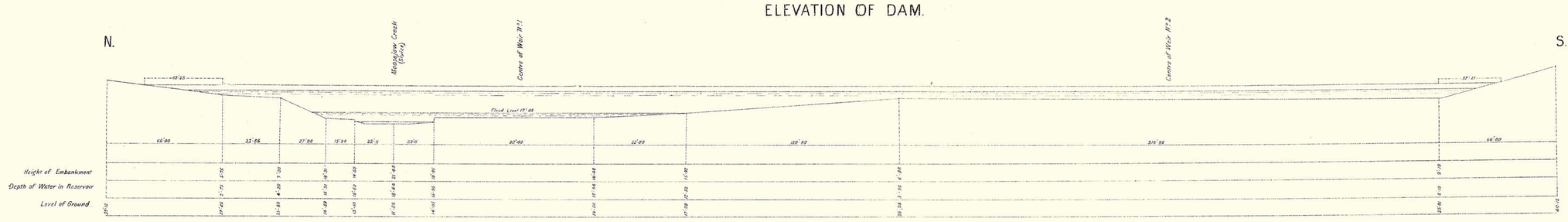
SUB-PARTY Nº 2.

1897.

ELEVATION AND PLAN OF DAM ON MOOSEJAW CREEK.

Tp 17 - R25 - W OF 2 Mn.

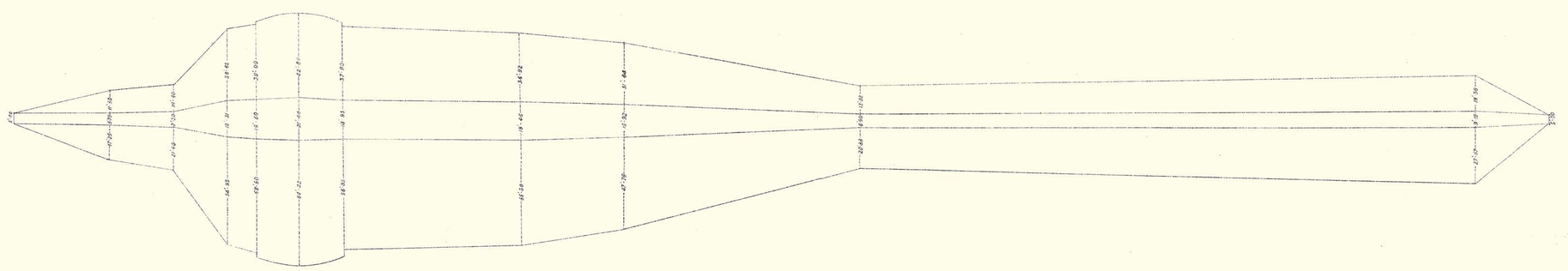
ELEVATION OF DAM.



PLAN.

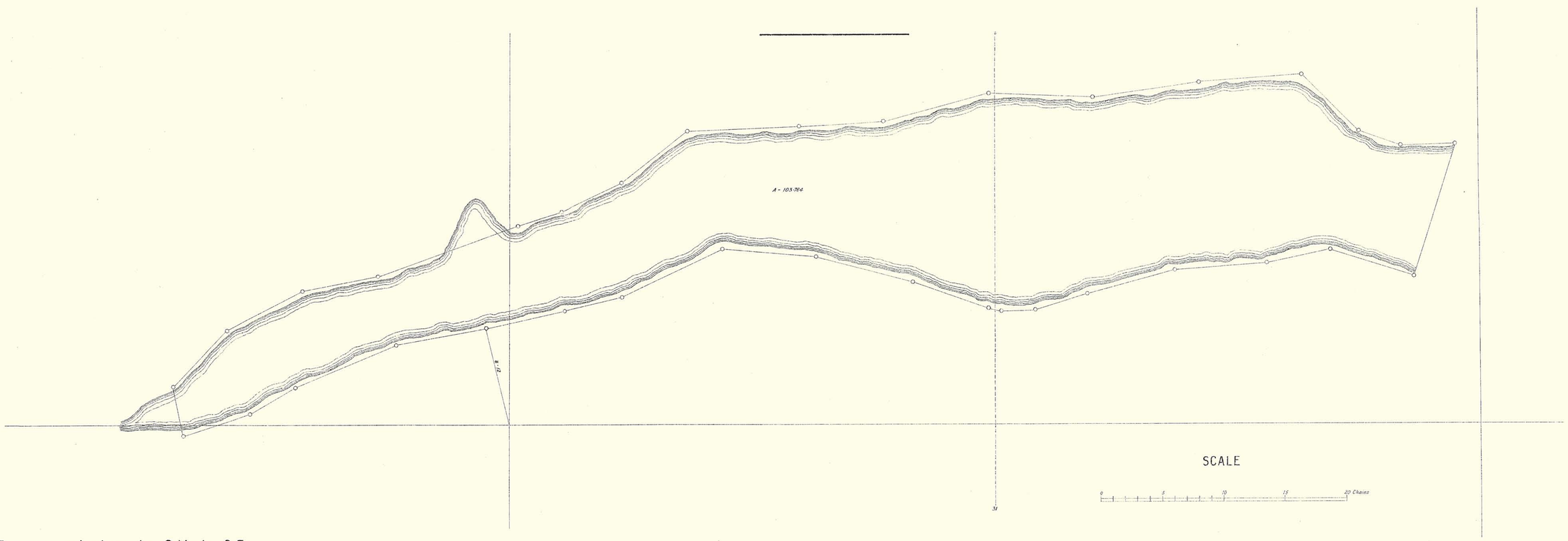
SCALE.

0 10 20 30 40 50 60 70 80 90 100 150 200 Feet



PLAN OF PROPOSED RESERVOIR ON MOOSEJAW CREEK

Tp 17 - R25 - W. OF 2 Mn.



Surveys and plans by O. Yorke C.E.

CANADIAN IRRIGATION SURVEYS.

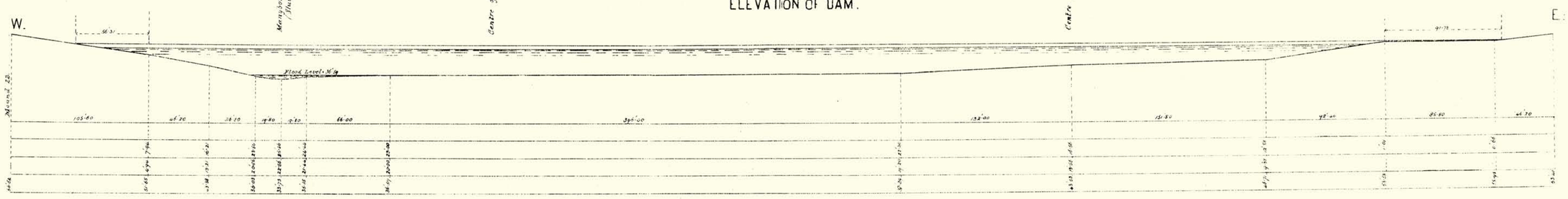
SUB-PARTY Nº2 1897

ELEVATION AND PLAN OF DAM ON MANYBONES CREEK

Tp 13 – R13 – W. or 2 Mn

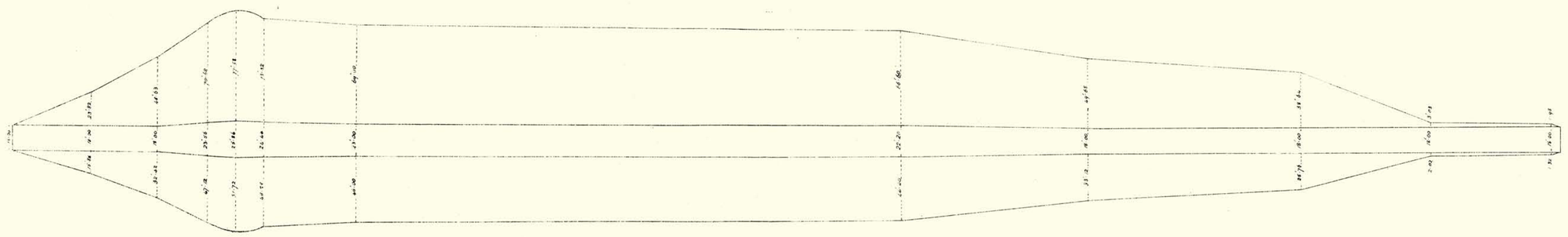
J.S. Dennis D.T.S
3/7/98

ELEVATION OF DAM.



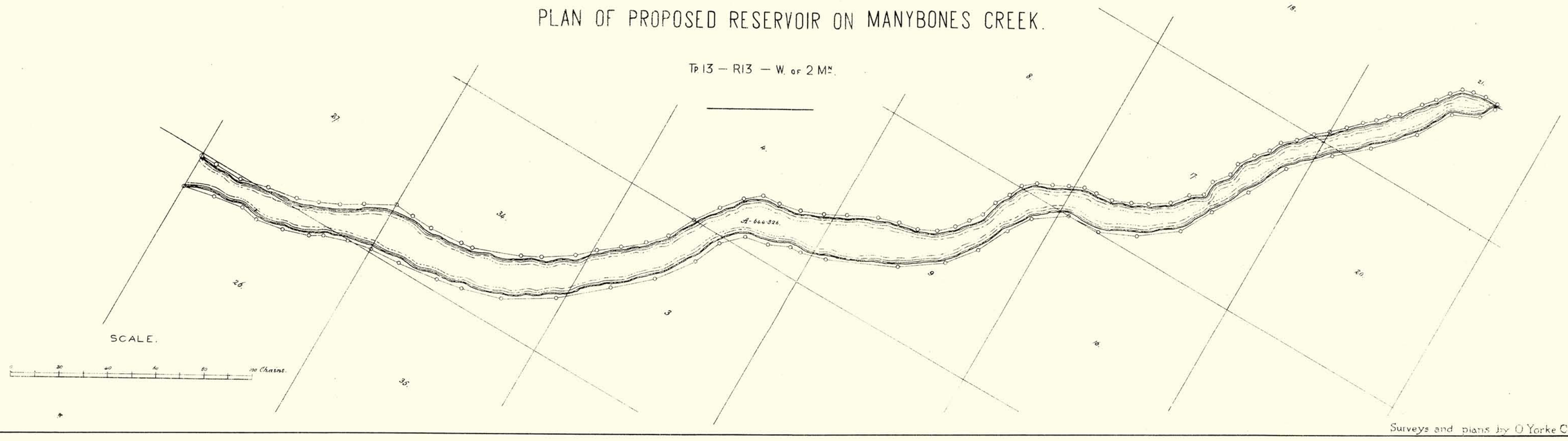
PLAN.

SCALE.



PLAN OF PROPOSED RESERVOIR ON MANYBONES CREEK.

Tp 13 – R13 – W. of 2 Mn.

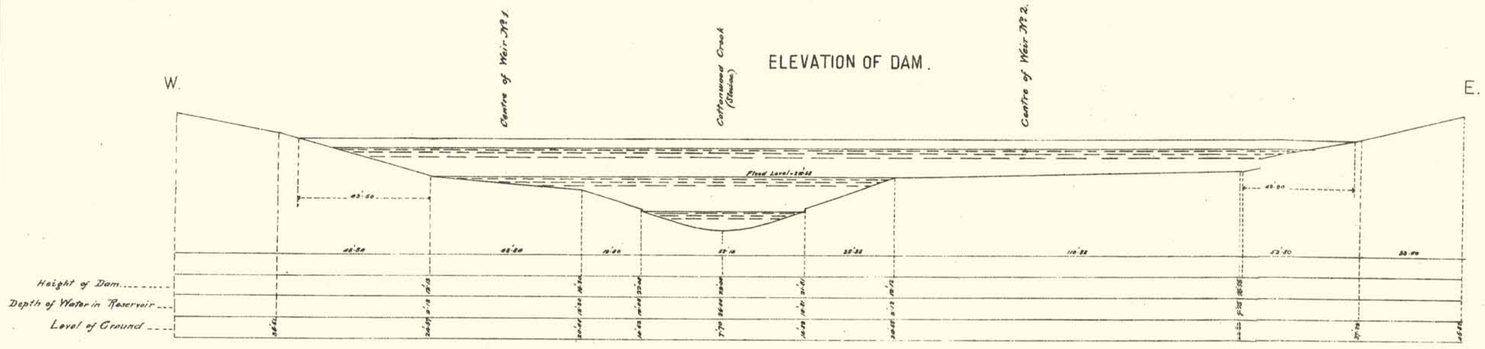


Surveys and plans by O'Yorke C.E.

ELEVATION AND PLAN OF DAM ON COTTONWOOD CREEK.

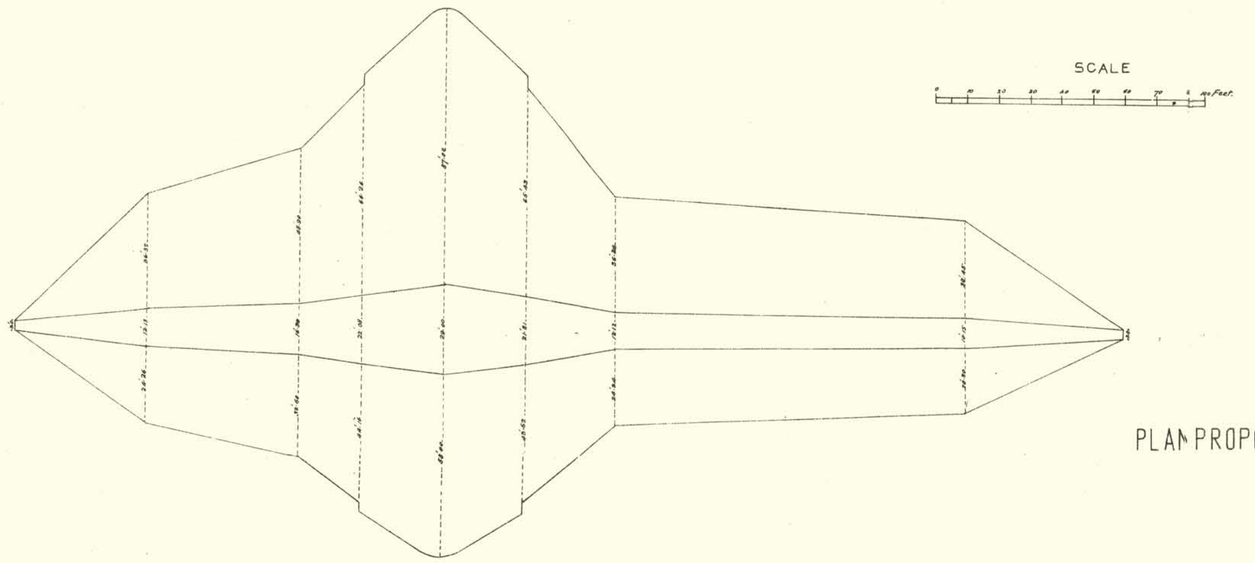
Tp 18 – R 22 – W. of 2 Mn.

ELEVATION OF DAM.



PLAN.

SCALE

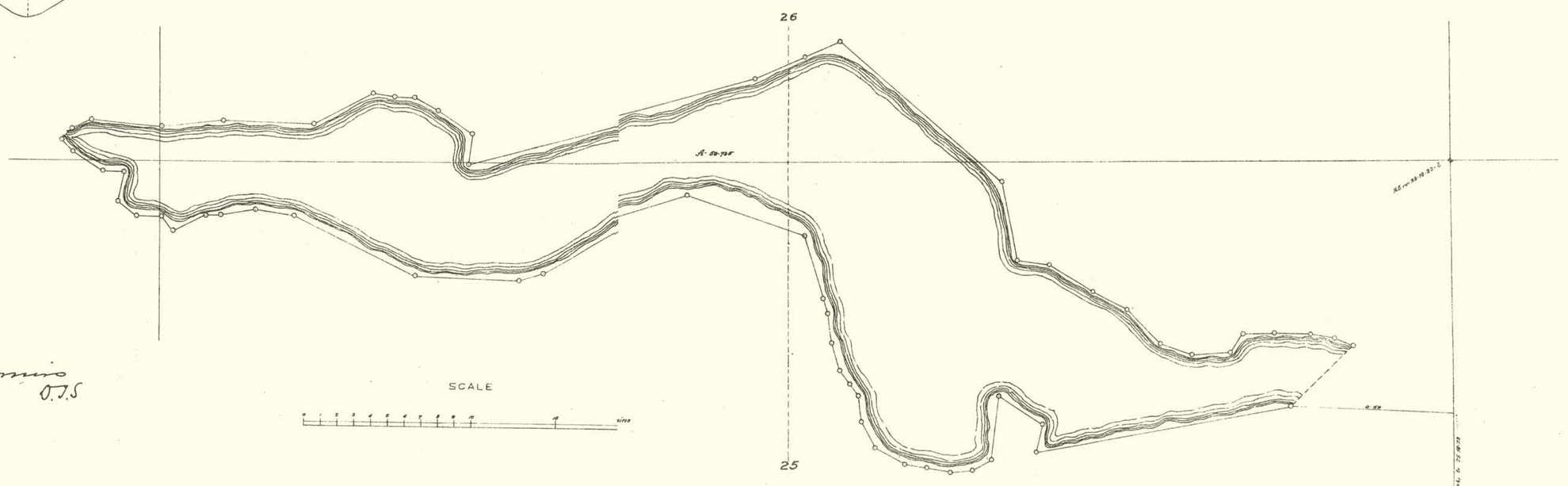


CANADIAN IRRIGATION SURVEYS.

SUB-PARTY Nº 2-1897.

PLAN PROPOSED RESERVOIR ON COTTONWOOD CREEK

Tp 18 – R 22 – W. of 2 Mn.



J. D. Annis O.L.S
3/7/98

Surveys and plans by O. Yorke C.E.

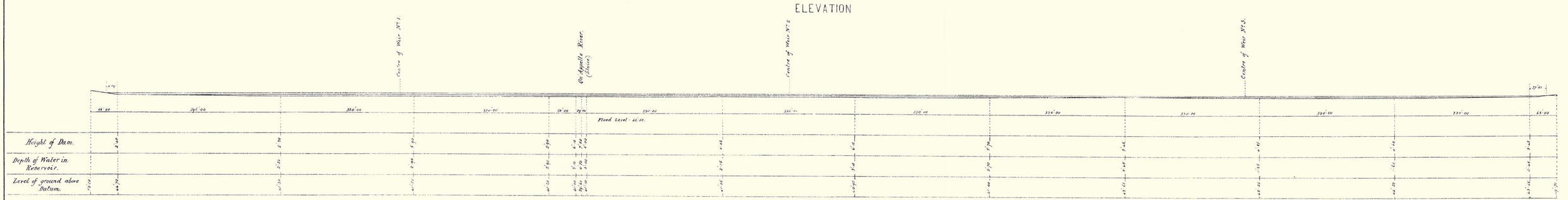
PLAN AND ELEVATION OF DAM IN QU'APPELLE VALLEY.

Tp 19 — R 25.

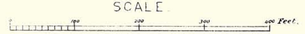
CANADIAN IRRIGATION SURVEYS.

SUB-PARTY N°2-1897.

ELEVATION



SCALE



PLAN.



Surveys and plans by O. Yorke C.E.

J. S. Dennis
3/2/98 DTS

— CANADIAN IRRIGATION SURVEYS —

— PARTY Nº 3. —

— PLAN OF DAM AND RESERVOIR —

— IN SECS. 10, 15 & 23, TP. 17, R. 12, W. 2ND M. —

Arthur O Wheeler
In charge of Irrigation Surveys
Calgary. May 1st 1899.

23

15

14

10

— WASTEWAY —

High water level

— GENERAL PLAN —
SCALE 400 FT = 1 INCH

— SECTION OF DAM —
SCALE 8 FT = 1 INCH

20' sand dressing for roadway
surface of water in Reservoir
Stone 2 to 1
Earth filling
clay puddle
6-0"

Top of proposed Dam
proposed surface of water

— PROFILE OF DAM —
HORIZONTAL SCALE 30 FT = 1 INCH
VERTICAL " 10 " "

Surveys and plans by J T Child C.E.

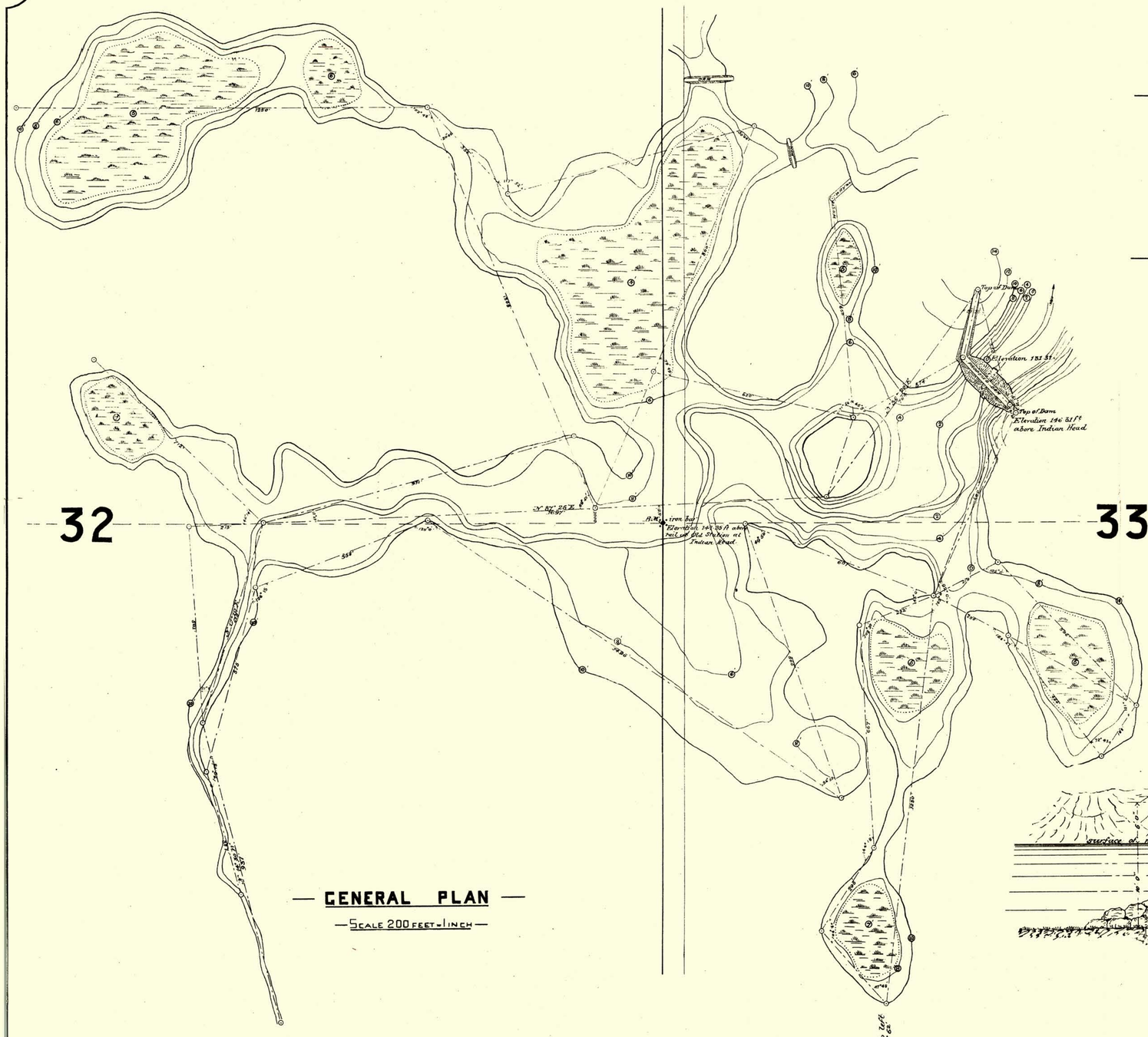
— CANADIAN IRRIGATION SURVEYS —

— PARTY Nº 3. —

— PLAN OF DAM AND RESERVOIR —

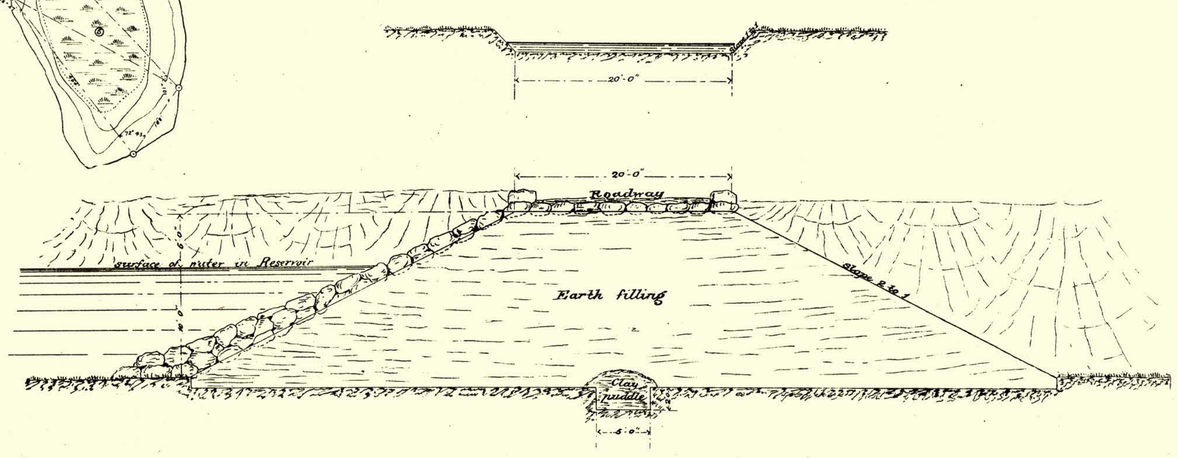
— IN SECS. 32. & 33, TP. 17, RGE. 13. WEST 2ND MERIDIAN —

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In charge of Irrigation Surveys
Calgary. May 1st 1899



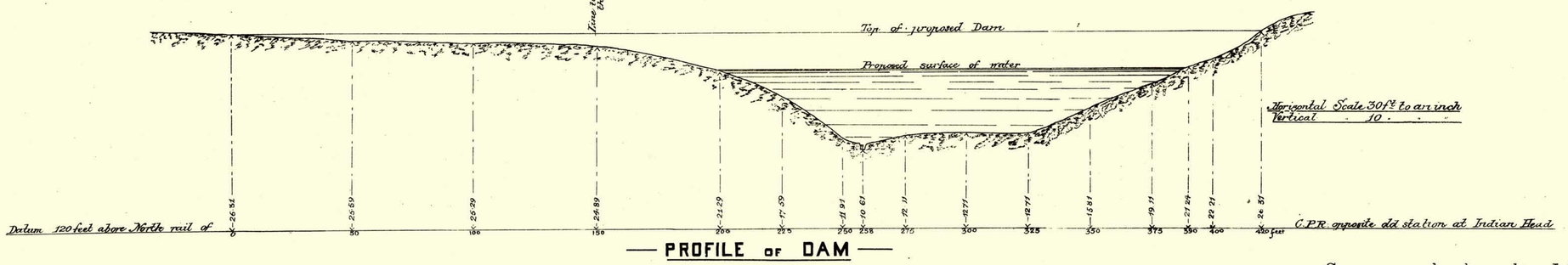
— GENERAL PLAN —

— SCALE 200 FEET = 1 INCH —



— CROSS SECTION OF DAM & WASTEWAY —

— SCALE 8 FEET = 1 INCH —



— PROFILE OF DAM —

Surveys and plans by J T Child CE

— CANADIAN IRRIGATION SURVEYS —

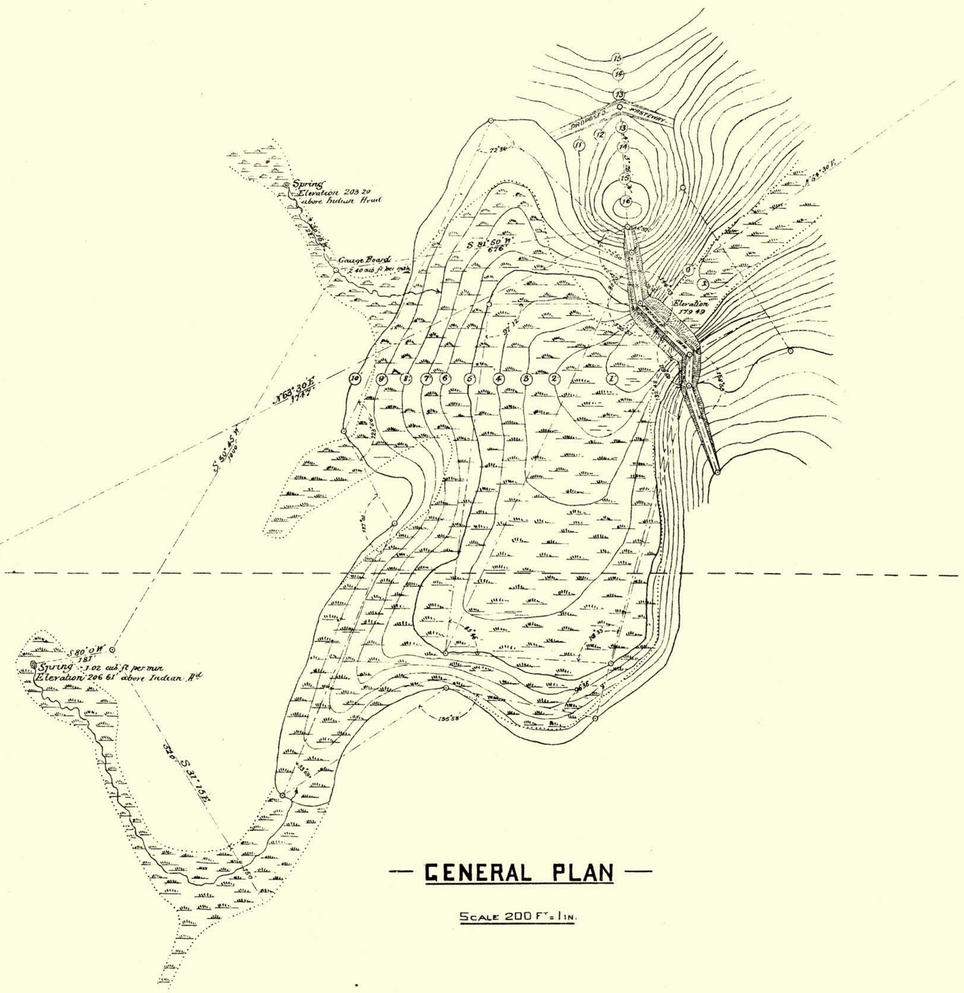
— PARTY Nº 3. —

— PLAN OF DAM AND RESERVOIR —

— IN —

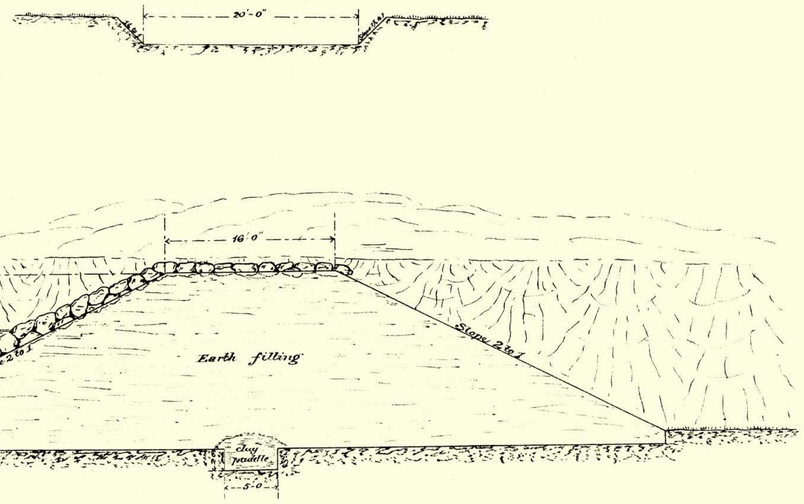
— SEC. 20, TP. 17, R. 13, WEST 2ND MERIDIAN —

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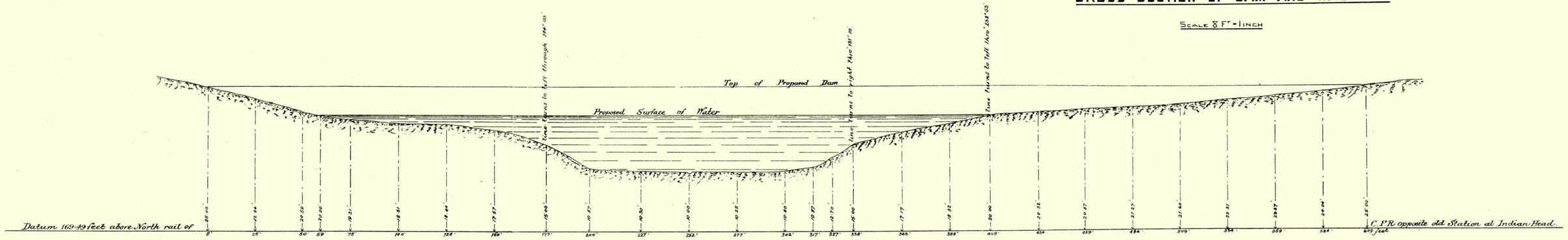
— GENERAL PLAN —

SCALE 200 FT = 1 IN.



— CROSS SECTION OF DAM AND WASTEWAY —

SCALE 8 FT = 1 INCH



Horizontal Scale 30 ft to an inch
Vertical " 10 ft " "

— PROFILE OF DAM —

SURVEY AND PLANS BY J. T. CHILD C.E.