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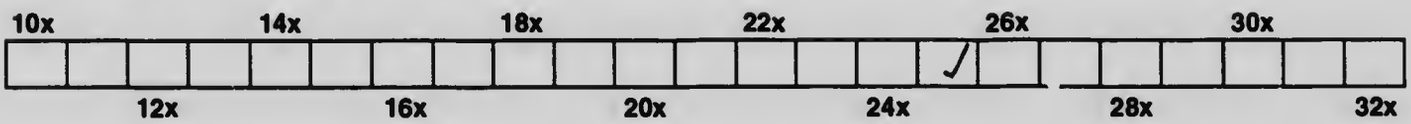

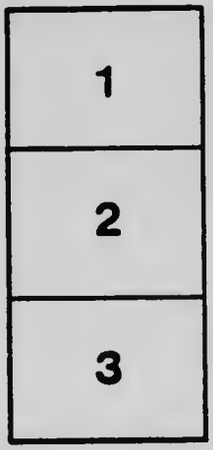

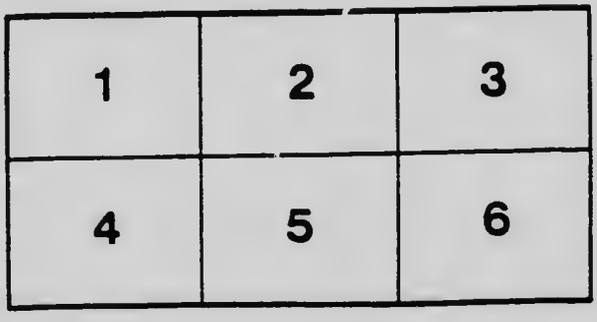

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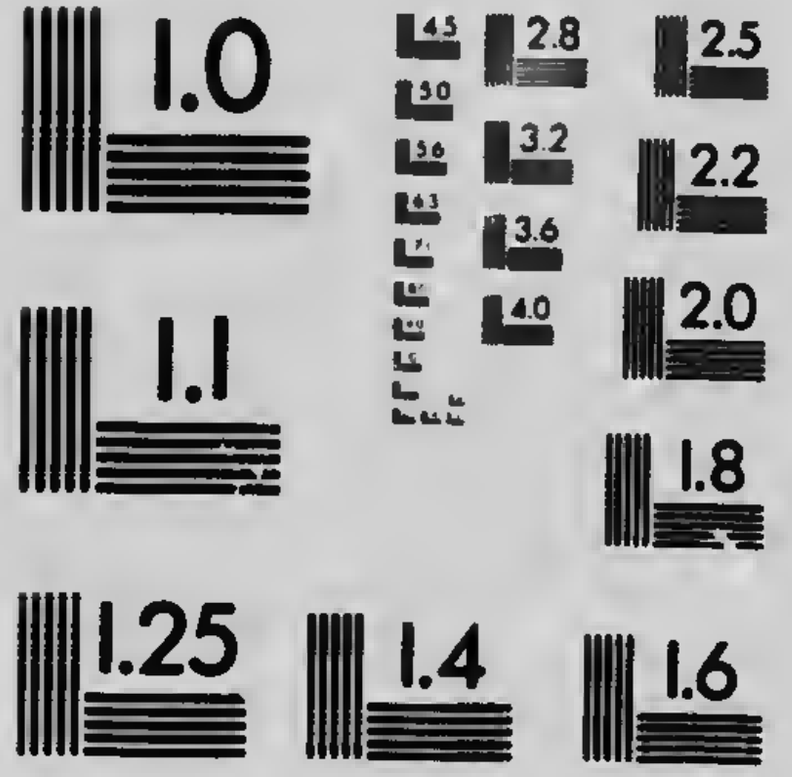

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DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J. B. CHALLIES, SUPT.

WATER RESOURCES PAPER NO. 5

PASQUIA
RECLAMATION PROJECT

BY

T. H. DUNN, C.E., O.L.S.

Prepared under the direction of the Superintendent of Water-Powers.

No. 11, PART 8, ANNUAL REPORT, 1913.

OTTAWA
GOVERNMENT PRINTING BUREAU
1914

DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J. B. Challies, Supt.

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REPORT

ON

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REPORT OF T. H. DUNN

J. B. CHARLES, Esq., C.E.,
Superintendent, Water Power Branch.

SIR,—In carrying out your instructions dated July 4, 1912, I have made a partial examination of the Saskatchewan river between The Pas and Cross lake, and also the flooded area contiguous to the river, with a view to determining the feasibility and desirability, from an agricultural point of view, of reclaiming these lands.

In endeavouring to carry out this work several deterrent and unforeseen factors entered into the problem which were absolutely unavoidable. We were continually hampered by wet weather and high winds, the latter condition rendering the lakes unnavigable and resulting in the loss by drowning of four of our party on September 6. This sad accident caused the total suspension of all engineering work for nearly three weeks, and at the end of that time when the work was taken up again it was impossible to procure men to take the places of those who were lost. We did succeed in getting a couple of Indians for a few days at a time, but the fall hunt had commenced and the lure was too strong to be resisted by a mere Indian.

In addition to this, my instructions called for all detailed surveys to be made by a power party sent out under your instructions by Mr. D. L. McLean, chief engineer of the Manitoba Hydrographic Survey. This party was at Grand Rapids in charge of Mr. E. B. Patterson who was making a survey of the rapids for power purposes and, although good progress was made throughout the season, the power work was not completed until about October 10, which was too late to permit of any new work being started, as the last boat on which the party could return to Winnipeg was leaving Grand Rapids on October 15.

The absence of these detailed surveys and the extreme shortness of the working season for the reasons mentioned makes it impossible for me to give definite answers to the questions propounded in your instructions.

Taking up these problems in the order in which they appear in your instructions, I will endeavour to give such a solution as would seem to be indicated by the information I have been able to secure, but, in some cases, the information is too meagre and the data too uncertain to justify me in hazarding an opinion.

The first question presented in the instructions is:—

> (1) Is it possible to lower Cedar lake to nearly the same elevation as Cross lake?

It is, of course, impracticable to bring these two lakes to quite the same elevation owing to the fall necessary to give the required discharge, but I do not consider this to be the problem which it is intended to present in this question.

Cedar lake has sufficient depth, except at a few points, to admit of the proposed lowering without damage to navigation.

That portion of the lake immediately adjoining the Narrows is shallow, and the excavations for the proposed canal would have to be continued about a quarter of a mile into the lake.

There is also a shoal off Rabbit point which has only three or four feet of water at certain times of the year, while near Dumeau island, at the west end of the lake, there is another shoal. Any scheme to lower Cedar lake would therefore necessitate the making of a cut through these shoals.

While the extent of this work is not definitely known, it is not thought to be a serious obstruction.

(2) What will be the immediate effect of such lowering?
(*a*) What acreage will be thereby reclaimed?
(*b*) What is the value of the area so reclaimed?

If Cedar lake be lowered, as proposed, an outlet will be thereby provided for a very large area, the extent of which has never been determined by any survey. An approximate boundary was shown by Mr. William Ogilvie, D.L.S., on his map of 1911, and from this I estimate the area to be about 2,000,000 acres. This land is at present either flooded or so isolated by the flooded area as to be almost totally inaccessible.

The water from this immense area would reach Cedar lake through the medium of the Saskatchewan and Summerberry rivers and the other natural watercourses of the country.

The area actually reclaimed by the lowering of the waters of Cedar lake alone would probably not amount to more than 20 per cent of this total area, or about 400,000 acres, and would be confined to the country adjoining Cedar lake at the west end and extending to Moose lake and westward along to Summerberry river. The reclamation of the balance of the two million acres could not be accomplished simply by the lowering of the lake, but this must be followed up by improvements in the Saskatchewan river at several points, notably at a point about 3½ miles upstream from Cedar Lake Post, at the Frying Pan, near Hill Island and the Wooden Tent.

In addition to this an interior system of drainage will have to be provided for the removal of pond water and for the run-off from the precipitation of the district.

This latter problem is not included in these investigations. The soil throughout this area is practically all alluvial in origin so far as is at present known.

It is impossible to place a value on this land until more is known about the interior. No samples of the soil of the interior have ever been taken owing to the fact that the land is pretty generally covered with water. The high water prevailing during the season of 1912 made this particularly difficult and unsatisfactory. It was not possible, with the instruments at our disposal, to take soil samples where the soil was covered with water.

(3) What will be the indirect effect of such lowering on the low-lying lands contiguous to the Saskatchewan river?
(*a*) Below The Pas?
(*b*) Above The Pas?

The lowering of the lake will provide an outlet for the water from all the lands below The Pas. This outlet constitutes an indirect benefit to the flooded area between the Frying Pan and The Pas.

This area, however, while greatly relieved of its burden, would not be in a position to derive full benefit from the outlet thus provided unless some improvement were made in the river itself. Such an improvement would involve the deepening of the river at points mentioned above.

If the lowering of Cedar lake be followed up with this suggested improvement in the river, the outlet will be brought within a reasonable distance from the lands it is proposed to drain and will be accessible to any scheme of interior drainage.

The effect above The Pas would be to lower the water slightly, but this would not be appreciable during the flood period owing chiefly to the fact that the Saskatchewan river takes a rather sharp turn to the left at The Pas and is much narrower at this point and for some distance below than it is above.

In addition to this the condition of high water originates at the sources of the river and progresses toward the outlet, being caused by the melting of snow in the Rocky mountains, and, naturally, the upstream districts, if sufficiently low, will be flooded first.

The result of these two conditions is that there is a flood at The Pas about three weeks before any flood occurs at Cedar lake, and it is practically certain that any

scheme of drainage which does not provide for the removal of the obstruction at The Pas could afford but little relief to the lands above The Pas.

(4) What effect will such lowering have on the Saskatchewan river proper, through the territory in question?

The lowering of Cedar lake will increase the velocity of the water in the Saskatchewan river and cause erosion of the soft materials comprising the sides and bottom of the river. At four or five places along the main river the bottom is hard and stony and will erode very slowly, if at all, as rock will be encountered at the turn, three and a half miles above Cedar Lake Post and at the Frying Pan. There is also a stony rapid in the channel known as Head river, but the Summerberry channel is free from rapids, and the sides and bottom are entirely of soft material which would erode with considerable facility. Unfortunately, however, this stream is narrow and would not accommodate, under the most favourable conditions for erosion for many years following the improvements, more than one-half of the flood discharge.

I do not anticipate any serious change in alignment of the river bed as a result of washing away the banks on the turns, as there are few, if any, turns sufficiently sharp to give rise to any serious erosion. This is a matter, however, which calls for further investigation.

(5) What effect will such lowering have on navigation throughout the area in question?

If a proper scheme of drainage be carried out, I consider the navigability of the waters will be greatly improved by the more or less uniform distribution of the fall.

Between Cedar and Cross lakes there are two rapids, viz., the Flying Post rapid and the Demi-Charge, the latter being a very heavy rapid, and not navigable. The total fall between the lakes is believed to be about 15 feet. This is Mr. Ogilvie's estimate, but no complete line of levels has been taken so far as I am aware. The construction of the proposed canal would reduce this fall to about four feet and thus remove every obstacle to navigation at this point. This, however, will render Cedar lake unnavigable at two points, and will have the effect of developing some rather shallow and strong rapids in the Saskatchewan river between Cedar Lake Post and The Pas.

It will be necessary to deepen these points in Cedar lake, and either to deepen the Saskatchewan at the points previously mentioned or confine navigation to the Summerberry channel during low water.

This deepening of the lake and river will be necessary for drainage in any case, and when completed will be of great benefit to navigation which is somewhat difficult at certain points during low water.

The absence of the detailed surveys which are so necessary between Cedar lake and Cross lake makes it impossible to make more than a very rough approximation of the cost of the work.

To construct a canal 1,200 feet wide along the course C-F, laid down on the plan, which course is 25,500 feet long, would cost in the neighborhood of $5,000,000. This canal would have a capacity of about 50,000 second feet and would provide for a flood of ordinary height, but would not prevent flooding in seasons of extra high water, occurring every three or four years.

To provide for a discharge above 50,000 second feet it will be necessary to deepen the river in the vicinity of the Narrows and Flying Post rapids at an additional cost of perhaps $1,000,000. It may be found more economical to widen the upper end of the canal than to deepen the river. The cross-section of the canal must be so designed as to preserve at least six feet of water during low-water periods

for purposes of navigation. As there is no survey on which to base this estimate, it must be considered as a very rough approximation.

No estimate of the cost of the work in Cedar lake and the river west of Cedar lake can be given at present.

To determine even approximately the cost of carrying out this scheme would require nothing less than the programme laid down in your 1912 instructions, and I cannot do better than recommend the continuance of the work along the lines cited therein.

It is desirable, however, that one important addition be made to this programme, and I strongly recommend that a survey and profile be made of the Saskatchewan river between Cedar lake and The Pas, together with cross-sections at all the rapids and an approximate classification of the materials likely to be excavated.

A more serious effort than anything heretofore undertaken must be made in order to determine the value and extent of the lands which it is sought to reclaim.

Regarding the reported rapid in Moose Lake creek near Moose lake I beg to report that an examination discloses the fact that no such rapid exists. No surveys will therefore be required at this point. There is, however, a shallow place in Moose lake at the mouth of the creek which will be discussed further on in my report.

A scheme so extensive as the one under consideration, and involving the expenditure of such a large sum of money, should not be undertaken without the fullest investigation. That such an investigation is desirable and justifiable on economic grounds is strongly supported by all the information so far obtained.

I therefore recommend that this work be proceeded with as outlined in your instructions and with the additions above mentioned as soon as navigation opens in the spring.

The attached report of my investigations is respectfully submitted.

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

THOS. H. DUNN, O.L.S., C.E.
Engineer in Charge of P.R.P.

Dated at Ottawa, this 7th day of March, 1913.

Itinerary.

On receiving my instructions of July 4, 1912, I immediately began preparations for the work and reported in Ottawa on July 6.

From this date until July 12, I was busy arranging for the necessary instruments and getting together such articles as would be required on the trip.

I arrived in Winnipeg on the evening of July 15, where I was detained until July 29, waiting for my instruments to arrive from Ottawa. This time was profitably spent in the purchase of supplies and camp outfit and in the very difficult business of hiring men. I found it impossible to get experienced men, so had to take the best who presented themselves in answer to my advertisement.

Considerable pains were taken to explain to the men the difficulties and dangers of the work they were expected to perform, and as they were for the most part inexperienced I was particularly careful not to bring any undue influence to bear on them to induce them to join the party, but rather the contrary.

Mr. O. W. N. Charlton, who was to act as my assistant, arrived from Toronto on July 28, and on the morning of the 29th we left for The Pas, with five men and the cook, one man of our party having failed to turn up.

We arrived in The Pas on July 30 and, while waiting for information from the Surveyor General's Department and also for some parts of my transit which had not

yet arrived from Ottawa, I made a trip up to the forks of the Pasquia river. This was done for the purpose of keeping the men together and because it was believed to be cheaper than staying at The Pas.

In ascending the Pasquia river we observed the same strange phenomenon mentioned by the late Mr. Ogilvie in his 1911 report. Instead of the Pasquia emptying into the Saskatchewan as it does under normal conditions, the Saskatchewan was emptying its waters into the Pasquia, resulting in a strong current 'upstream' in the latter river. This proved of great assistance to us going up but not so on the return journey.

We left The Pas on August 3 and returned on August 12, experiencing on this latter date the worst wind and rain storm of the season. So delayed were we by this storm that we did not reach The Pas until nine o'clock at night and were thoroughly drenched and shivering in the cold north wind.

Pasquia Reclamation Project. Pasquia River. 11 miles below the Pas Forks.

We made an approximate survey of a portion of the Pasquia river but, owing to the fierceness of the storm, we could not connect it across the lake, barely succeeding in saving our canoes from swamping.

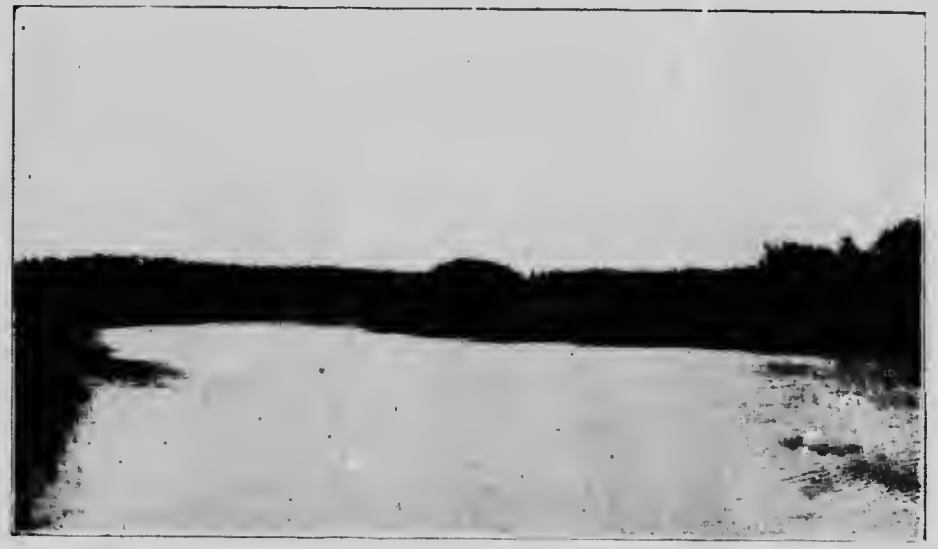
On our arrival at The Pas we found information for which we had been waiting had arrived, so after drying our clothes and provisions and attending to correspondence, we divided our provisions into two parts, one of which we stored at The Pas, and the other we loaded into our canoes and, on August 15, started down the Saskatchewan river on our way to Cross lake. We took no soundings on the way down, as we were anxious to reach Cross lake before the Power party at Grand rapids completed their power survey, and also because the water was so high that it was slow and difficult work taking soundings. The shoals which were plainly visible at ordinary or low water could not be located without great labour. A short distance below The Pas I found the banks of the Saskatchewan were only a few feet above the water and very narrow, while lower down the river was overflowing its banks in many places and the water rushing away in great volumes into the innumerable swamps and shallow lakes which comprise the interior. At this time there was no chance of

getting soil samples except along the banks of the stream, which would be of little value in determining the quality of the soil in the interior.

Approaching Cedar lake we found a perfect maze of channels branching off from the main Saskatchewan, and each carrying its burden of waters by its own chosen route towards Cedar lake. Some of these channels are larger than the one we were following, which is the boat channel. There are short cuts in some places for the initiated, but we kept to the main channel.

We arrived at Cedar Lake Post on August 17, where we were kindly received by Mr. Duff, the factor for the Hudson's Bay Company, and Mr. Fraser, who was in charge of the Anglican Mission at The Pas but acting temporarily in that capacity at Cedar Lake Mission.

The Indian settlement on the reserve here is called Chemawawin, which is 'The place of drawing the seine.' It has been called by Dr. Klotz and Mr. Ogilvie, Chemi-



Pasquia Reclamation Project. Pasquia River. 4 miles below the Pas Forks.

hawin, but those who know the Cree language well say that this is not correct. The Indians generally slur the word and call it 'Chemihawn.'

Whatever may have been its reputation in the past it is rather a poor fishing ground at present, except for jackfish. It is necessary to go to Cedar lake for whitefish and sturgeon.

Arriving at Cedar Lake Post on Saturday we remained over Sunday, and on Monday 19 we engaged two Indians to take us to Cross lake. We had considerable difficulty in getting Indians to accompany us, as any kind of real work does not appeal to them very strongly. We found only two on the reserve who were willing to go and these would only promise to stay one week and that on the condition that they receive $2.50 per day each instead of the regular $1.25 per day regularly paid by the Hudson's Bay Company at this post. After taking some observations for latitude at Cedar Lake Post and resting over Sunday we left on Monday, August 19, for Cross lake.

Owing to the prevalence of high winds on Cedar lake much time was lost as it was impossible to cross the lake except under the most favourable conditions. We finally arrived at Cross lake on the evening of August 22 and made camp at the mouth of the river on the north bank.

On August 23, after attending to correspondence, I left Mr. Charlton in charge of the camp with instructions to begin work at once and, taking the two Indians, I started for Grand Rapids, where I arrived the same evening. Here I found Mr. Patterson in charge of Mr. McLean's power party, and learned from him that it would be near the close of the season before the power survey would be completed, and that I could not expect much assistance from that quarter in making my detailed surveys. I therefore returned to my camp at Cross lake on August 24, where I found that work had been commenced on the Cross Lake survey according to my instructions. Immediately upon my return from Grand Rapids the Indian guides prepared to leave for Cedar Lake Post. They had hired on the condition that they should be at liberty to return home upon our arrival at Cross lake on the return trip and this was the

Pasquia Reclamation Project. Pasquia River. Grass land near Forks.

only basis on which they would consent to go. I now endeavoured to get them to remain during the balance of the season but they refused absolutely.

In view of the fact that Mr. McLean's survey party in charge of Mr. E. B. Patterson, at Grand Rapids, would not be through with their work in time to make any surveys for me, I decided to undertake a part, at least, of this work myself.

Owing, however, to continued bad weather with very high winds which prevented us from going on the lake with canoes, I had to abandon this idea of attempting work for which we had not outfitted. While encamped at Cross lake I established a meridian by observations on Polaris and extended the line one and a half miles north for the purpose of examining the interior. I also determined the latitude and longitude as nearly as possible with the instruments at my disposal.

Whenever the weather permitted we examined the shores of Cross lake and explored the little known portion of its northern extension, at the same time making a rough survey of the northwest shore. It was while engaged in this work on September 6, that four labourers of my party were lost through drowning. In this connection I wish to say that the two Peterborough canoes used by my party were new and of large size and good model. They had not been damaged in any way and did not leak. I also had one very much smaller chestnut canoe which I used myself and this latter canoe was used by my assistant, Mr. Charlton, and the rodman, Mr. Merritt, on the fateful day, while the four men who were drowned were in one of the large

Peterboroughs. There was no freight in the large canoe except four axes and a levelling rod, all of which lay in the bottom of the canoe. The following statement furnished to the Royal North West Mounted Police gives the details of what took place after leaving camp:—

CROSS LAKE, MAN., September 21, 1912.

Statement of O. W. N. Charlton, Assistant Engineer to Thos. H. Dunn, C.E., Engineer In charge P. R. P., W. P. Branch, Department Interior, Ottawa.

'I hereby state:—

'That on Friday September 6, 1912, I, O. W. N. Charlton, was out in Cross lake in canoe in company with Arthur Merritt, rodman of our party, and behind me in larger canoe were four men of our party, known as Fred McLennan, Hugh W. Cochrane, George A. White and William McMullen (chainman and axeman); these four had instructions from me to follow my canoe and keep close in shore. On reaching northeast corner from camp, the lake which had been rough became worse and high wind started. I then observed that the four men as named above in canoe were acting on their own initiative and endeavouring to make shore of island to east of mainland, evidently to obtain protection from wind. A few minutes later on looking round I could plainly see that members of the late party were placing their weight on side of canoe to open to wind thereby exposing their craft to great danger. I endeavoured to turn, but could not do so on account of heavy seas, at same time shipping considerable water in my own canoe. At this time the two canoes were widely separated, the larger one evidently having weathered the gale. A short time later the party were seen paddling parallel to shore apparently O.K. This was last sight of party. My canoe was blown about two miles down lake, and I beached it as soon as possible.

'The seas by now were extremely heavy and wind very strong. I immediately took my transit from case and swept shore lines for sight of party. I was unable to locate them at this time and thought that they had reached shore. We were forced to remain on point from 10.30 a.m. until 3 p.m. when wind changed and during lull I returned to main camp. Mr. Dunn and myself leaving immediately to search for party, but found no trace.

'On September 15, after nine days' search three bodies were recovered in lake, death evidently being due to drowning. These bodies were interred at Mission cemetery (Anglican) at Grand Rapids.

'On September 18 the police boat, in charge of Corporal Grennan, arrived from Le Pas at 3 p.m. and search was continued.

'On Friday, September 20, 1912, at 8 a.m. the body of the late William McMullen was recovered near point where last seen on day of accident. The body was interred on Saturday, September 21, on island, the body being interred here on account of emaciated condition.

'All bodies on recovery showed signs of accident being totally unexpected, none having disrobed, and being in their full bush kit, which made swimming very difficult.'

(Sgd.) O. W. N. CHARLTON.

'I, Arthur Merritt, rodman of the above party, hereby corroborate the above statement with the addition that when we noticed the canoes were separated we shouted to the four men to turn back, but evidently they did not hear us.'

(Sgd.) ARTHUR MERRITT.

I wish to add to the above statement that during the preceding night, and in the morning of September 6, the wind was off the west shore and while my instructions

at first were that no wor[illegible]l be done on the lake that day I afterwards consented, on request from Mr. Char[illegible] to allow him to continue the work of the day before. This was in consequence of the fact that the wind had largely subsided and on the understanding that they would keep close to the west shore, where they would be protected from the wind. It seems that by the time the canoes reached a point 1¾ miles from camp the wind shifted to the southeast and increased in intensity. Just why the men in the large canoe abandoned the same course of running down the wind and attempted to cross at right angles to the wind and in a direction not necessary to reach their destination it is impossible even to guess. All the evidence points to the fact that their canoe was upset by the load being all placed on one side as mentioned in Mr. Charlton's statement.

In our search for the bodies we had every assistance possible from Mr. Patterson and party of Grand Rapids, and in interring the bodies we were treated with great kindness by Mr. Morris, the Anglican missionary at Grand Rapids, who looked after the digging of the graves and conducted the funeral service.

On Monday, September 9, we found the canoe and paddles and some clothing, and concluding that the worst had happened I immediately had drags constructed and engaged nine Indians, all I could get, and put them to work dragging the lake in the vicinity of the place where the canoe was last seen. Nothing, however, was found until the eighth day, when one body came to the surface, and on the ninth day two bodies were found floating on the water. These proved to be the bodies of Hugh W. Cochrane, George A. White and Fred. McLennan, and were buried in the Anglican cemetery at Grand Rapids in the order here named, counting from south to north, on the sixteenth day of September, 1912.

I returned to Cross lake on the 17th and, leaving Mr. Charlton in charge of the camp, started for The Pas on the 18th, with two Indians who had that day arrived from Cedar lake in response to a message sent in accordance with a previous arrangement. I wished to go to The Pas to confer with the Royal Northwest Mounted Police, and also to communicate with the department. I had the misfortune to miss the police on Cedar lake as Corporal Greenwood's canoe went around Rabbit point while I made a portage across it.

The corporal had received a letter from me, which I had sent some days before with the Bishop's party and acting promptly arrived at Cross Lake camp on September 18, the same day I had left. The police, in company with Mr. Charlton, found the body of William McMullen on September 20, and buried it on Channel Island on September 21.

Owing to exceptionally fine weather on September 18 and very hard work on the part of my Indians, we made a record trip from Cross lake and reached Cedar Lake Post at 8.30 p.m. the same day. This was the last of the fine weather, however, on our trip and we had to fight every inch of the way from Cedar Lake Post to The Pas against a fierce head wind and, for the most part, in a downpour of rain.

We left Cedar Lake Post on September 19 at 2 p.m. and did not reach The Pas until 9.30 p.m. September 22. The weather was now very cold and the rain had turned to sleet.

After communicating with the department and giving a statement of the drowning accident to the police, I arranged with Mr. T. H. P. Lamb, of Moose lake, to take me down to the Narrows in his launch but, before leaving, I received a telegram from the department asking me to go to Winnipeg for a conference regarding the reclamation project.

I returned to The Pas on October 3, and, on arrival there, I found, to my great surprise, that the sole remaining labourer of my party was there to meet me. It seems he had taken ill shortly after I had left camp and had come to The Pas with the police, leaving Mr. Charlton alone with the cook to carry on the work. This caused me great anxiety as I knew no Indians could be secured for more than a day or two at most as they were all out on the hunt and making from $4 to $20 per day by the sale of muskrat skins.

I therefore made all haste to return to camp and, after making a claim for deep-water sounding, I started down the river on October 5 in company with Mr. Lamb and my last remaining labourer, who had now completely recovered from his recent illness.

My arrangement with Mr. Lamb necessitated our going by way of Moose lake, at which point we arrived the same evening, but owing to darkness and a high north wind we could not enter the lake with our launch but had to walk along the shore to reach Mr. Lamb's home at The Post, a distance of one and a half miles westerly. This necessitated the fording of a small creek, the waters of which were somewhat swollen by the north blow.

We remained at Moose lake over Sunday comfortably housed in Mr. Lamb's fine new house. Mr. Lamb has also a good store at Moose lake, well supplied with all the necessaries and many luxuries.

On Monday, October 7, we went to Cedar Lake Post and thence to Cedar lake where we camped on an island at the west end of the lake. The wind was high and rising, and in the morning we found we could not venture on the lake so remained in camp, wind bound until the following morning.

We crossed Cedar lake on October 9, but missed Mr. Charlton's camp owing to misdirection received at Cedar Lake Post. We camped just above the Dean-Charge rapid and on the following morning went down to the old camp at Cross lake where we were informed by Indians that Mr. Charlton was in camp on the northerly shore of Cedar lake a short distance above the Narrows. We were soon at camp and just in time as they had their canoes loaded and were about to make a start to try and cross the lake and reach Chemawawin, since no further work could be done with the party reduced to one engineer and the cook.

I learned that a couple of Indians had joined the party for a time but these had left some days before my arrival.

After taking some soundings in the lake I arranged for an early departure for The Pas as my arrangement with Mr. Lamb was to last only one week from Moose lake until our return to The Pas. His business would not permit him to remain longer and, having lost our men and one canoe, we had no other way to get back except by means of the launch. We arrived at The Pas on October 14 and on 15th I paid off my one remaining man and cook. On the 16th I was fortunate enough to make arrangements with Mr. Jackson, the inspector of Indian Agencies, by which I was permitted to use the Indian Department launch *Okema* for a trip to Cedar lake, and as the water was now falling quite rapidly I hoped to be able to get some soundings in the Saskatchewan river. I therefore purchased the necessary gasoline and engaged a man to run the engine and started down the river again on October 17. We reached Cedar Lake Post on the 18th and started on the return journey on the 19th. On the 20th we encountered a blinding snow storm which prevented our travelling and interfered materially with the building of fires for we had to cook outside, although we were comfortably housed aboard at night, as the launch was full cabined.

We took soundings at several points along the river and returned to The Pas on October 23. On the 24th we stored our outfit, and on 25th we left for Winnipeg.

HISTORY AND GENERAL OUTLINE OF WORK.

In the provinces of Manitoba and Saskatchewan, between latitude 53° 10′ and 54° 10′ and longitude 100° and 103°, lies a very extensive area of drowned land. The flooding of this valuable area is caused by the overflow of the Saskatchewan river during the warm weather in the summer when the snow melts in the Rocky Mountains. The course of the Saskatchewan is crossed near its outlet into lake Winnipeg by an extensive rocky ridge forming a very heavy rapid in the river, known as Grand rapids. This occurs at about three miles from lake Winnipeg.

About fourteen miles further up the river there is another rocky obstruction forming the Demi-Charge rapids just at the entrance of the Saskatchewan river into Cross lake and between Cross lake and Grand rapids are two lesser rapids known as Cross Lake rapids and Red Rock rapids. Just above the Demi-Charge rapids is Flying Post rapids, which is comparatively unimportant.

These five rapids are distributed along the river between Cedar lake and lake Winnipeg, a distance of about 22 miles. In this 22 miles there is a fall of about 119 feet, or an average of 5·41 feet per mile, while from The Pas to Cedar lake, a distance of 75 miles, the fall is believed to be approximately ·32 feet per mile.

As the grades on the upper reaches of the river are very heavy it is not difficult to see what must happen to the portion of the river which lies between these heavy grades on the west and the rocky obstructions on the east.

This flooded condition has often been observed and noted by explorers, and suggestions have been made as to the possibility and desirability of reclaiming the area. It was not, however, until the year 1910 that any active attention was given to the matter. The late Mr. R. E. Young, then chief geographer of the department, urged that a reconnaissance investigation be made in the field, and the late William Ogilvie was instructed to pass through the district on his way, in the summer of 1910, to Grand rapids and the Nelson river, with a view to a preliminary examination of the possibility of draining this district or reclaiming any considerable area and, based on his recommendations to Mr. Young, he was instructed to make a special examination of the flooded area during the following summer. As a result of Mr. Ogilvie's investigations during the summer of 1911 a very interesting and instructive report and plan was filed in this department.

The very encouraging information contained in this report induced the department to continue the investigations in order to obtain more definite information concerning the engineering problems which still remained so largely a matter of opinion and conjecture. This led to the investigation which I conducted under your instructions in the season of 1912.

The plan suggested for the reclamation of this area is the construction of a canal through the rocky barrier between Cedar lake and Cross lake and thereby reducing the elevation of the surface of Cedar lake to that of Cross lake. Should this be found insufficient, it has been further suggested that the elevation of both Cross and Cedar lakes might be lowered some four or five feet by making a cut through Cross lake rapids.

The soil of the whole flooded area may be described as alluvial, forming the bottom of what was once an extensive lake which has been gradually, but not completely, drained by the slow process of erosion and breaking away of the rock barriers on this eastern margin.

In addition to this gradual wearing away of the rock barrier the more rapid action of building up the old lake bottom by the deposit of silt from the heavily charged waters of the Saskatchewan has also been going on. This deposit of silt ceases, however, as soon as the soil surface reaches the level of high water and then the work of upbuilding is taken up by the growth and decay of vegetation.

It was suggested by Mr. Forward, then an engineer in the Public Works Department, in a reconnaissance report to his department in 1909 on the navigation of the Saskatchewan river, that if the river were dammed and the drowned area flooded more deeply the deposit of silt would raise the soil surface to such a height that the removal of the dam and consequent lowering of the impounded waters would leave the land sufficiently dry for cultivation.

It is extremely doubtful if such a result would follow such action, as the deposit of silt in any considerable quantity requires periodical flooding and not continuous flooding as in a lake. The lake formed by the proposed dam would not be different from Cedar lake, which is not filling to any great extent except at the east end, and where the silt-charged waters of the Saskatchewan come in contact with the still

Pasquia Reclamation Project. Demi Charge Rapids & Cross Lake. Cross Lake Camp.

Pasquia Reclamation Project. Cross Lake and Calico Is. from Cross Lake Camp.

waters of the lake. So much of the silt is deposited at and near this point that very little ever reaches the remoter portions of the lake.

Undoubtedly there is no way to reclaim this land for agricultural purposes, except by a canal between Cedar and Cross lakes. It could not be drained into lake Winnipegosis as that lake is practically on the same level as Cedar lake, and would have to be lowered before it would be available as an outlet for Saskatchewan waters. Some benefit might, in the years to come, be derived from the diversion of the upper waters for irrigation purposes, but this is not likely to be appreciable.

No argument or finding, based on observations of the action of any section of a river, more or less remote from its outlet, can avail against this proposal which contemplates the improvement of the outlet itself. The fall at the outlet of 119 feet in 22 miles takes it out of the class with the Nile, Mississippi or Danube.

It therefore remains to find the most economical route for a canal to lower Cedar lake sufficiently to relieve the drowned area of its burden of waters.

Cross Lake.

According to the traverse made by Dr. Klotz and embodied in his report in 1881, the width of Cross lake from Calico island to the point at which the river leaves the lake on the east side is 4¼ miles. The length from north to south is about 17 miles.

The northern portion of this lake is long and narrow and has several islands. It was but little known previous to 1912 as no survey had been made heretofore.

The portion south of Channel island is somewhat circular in shape, is entirely open and free from islands and of good depth. There is quite a noticeable current across the lake from the point where the Saskatchewan river debouches through the Demi-Charge rapid into Cross lake, on the west side, to Cross lake rapid, where the lake discharges its waters into the river on the east side.

On Mr. Ogilvie's plan, dated June 12, 1912, the elevation of Cross lake is given at 812 feet, and in White's book of altitudes it is given at 822 feet.

Taking the elevation of lake Winnipeg at 715 feet and adding 105 feet, the difference in elevation between lake Winnipeg and Cross lake, as determined by E. H. Patterson, C.E., in 1912, we have for the elevation of Cross lake, 820 feet. The difference of 112 feet in elevation between lake Winnipeg and Cross lake, as given in White's book of altitudes, is improbable.

The latitude of Cross Lake camp at the foot of the Demi-Charge rapid is 53° 10′ 23″, and the longitude is 99° 43′ 26″. These results must be considered as approximate, especially the longitude, as we were not provided with the instruments necessary for making close determinations.

The south end of the lake being open is subject to high winds and rough water.

A fairly accurate survey was made of the northwest shore of Cross lake, locating also the islands and some points on the east shore. Soundings were also taken which indicate a wide range of variation in depth of water. In the north and south the water is very deep with a channel between these points of 12 to 30 feet in depth. An examination of Cranberry bay and Lamb's bay, two of the possible outlets for the proposed canal, indicates a sufficient depth of water within a short distance from shore.

Cross Lake to Cedar Lake.

The connecting link between Cedar lake and Cross lake is formed by a section of the Saskatchewan river, 6 miles in length and 1,200 feet wide at its narrowest point. The most important feature in this stretch is the Demi-Charge rapid, which occurs at its outlet into Cross lake. The river is here partially obstructed by two islands, Spruce island on the south and Calico island on the north side.

The distance between Spruce island and the north shore is 1,200 feet, but there is, in addition to this, a large volume of water flowing through the channel to the south side of Spruce island.

Above the Demi-Charge the current is strong until Anchor point is reached. Between Anchor point and Flying Post rapids there is a wide lake-like expansion with little current and having a depth of from 7 to 12 feet.

The Flying Post rapids is very shallow in places with a boulder strewn bottom having only 2 or 3 feet of water, but there is a narrow channel just west of Dividing island which is 5 to 7 feet in depth. The river is narrower and deeper on the west side of Dividing island, but very shallow on the east side. Dividing island is low and rocky, of the same formation as the surrounding country.

Pasquia Reclamation Project. Looking across head of Demi-Charge Rapids.

About a mile above Dividing island is the Narrows, which is a very narrow passage between Moose island and the south shore, and forms the only navigable channel by which entrance may be made into the river from Cedar lake. To the north of Moose island there is a wide but very shallow channel which is not safe to navigate with any kind of craft.

The river runs in a southeasterly direction and the southwest shore is quite high in many places and is rocky throughout. The northeast shore is also rocky, but is low and was flooded in many places in 1912.

Cedar Lake.

Cedar lake is quite a large expanse of water about 30 miles in length and 12 miles in width at its widest part, exclusive of the north arm which is, in itself, about twenty miles long. It is studded with islands at both the east and west ends, but with a large open expanse in the centre. It is partially divided by a long, narrow peninsula ending in Rabbit point and extending from the north shore to within about 5 miles of High portage on the south shore.

The regular canoe route is around by the north shore to 'the Crossing,' thence to Rabbit point and from there to the Narrows, while the larger craft go direct from Duncan island to Rabbit point, which gives a course about due east, magnetic. The depth of the water along the boat channel is 25 to 35 feet, except near Duncan island, off Rabbit point, and in the immediate vicinity of the Narrows. As stated elsewhere

Pasqua Reclamation Project. Looking up the Dead Channel from Cross Lake Camp.

in this report, the water is only 3 to 4 feet deep off Rabbit point during low water according to Captain Ross. The water is 8 feet deep at the Narrows but deepens rapidly towards the west to 25 feet. While the water is known to be shallow at Duncan island there is no definite information as to the exact depth.

The west end of the lake is affected to a considerable extent by the deposit of silt, which is more noticeable, however, in the lower reaches of the Saskatchewan river where it empties into the lake. This material will probably all be removed by the increased current due to the lowering of the lake, but should any remain it will be very easy of removal.

The shores and islands of Cedar lake are mostly rocky and covered with spruce and poplar, but in some places they are low and lead to muskeg in the interior. About the mouth of the river, however, there is an immense reed bed growing on the soft silt deposited from the over-charged waters.

The central portion of the lake is wind swept, and great care should be exercised in navigating with small craft. It is not safe to attempt to cross the main body of the lake in canoes.

Saskatchewan River.

That portion of the Saskatchewan between The Pas and Cedar lake forms the third link in the chain of the proposed scheme of drainage, but is the second in importance. This river is about 800 feet wide at The Pas at its narrowest point and it varies from 200 to 1,500 feet or more in its course to Cedar lake. Above The Pas there is a very wide open stretch of river which suddenly narrows and turns to the left at The Pas, with the result that in periods of high water the Saskatchewan below The Pas cannot accommodate the flood and the water rushes up

Pasquia Reclamation Project. Looking down Demi-Charge Rapids.

the Pasquia river with great velocity and enters Pasquia lake and the low lands surrounding the lake. This has the effect of preventing any rise in the water at Cedar lake for two or three weeks after the flood commences at The Pas and will prove of great value in any scheme of drainage which aims only at the relief of lands lying below The Pas, but will effectually prevent the benefits extended to the lands below The Pas from being enjoyed to any great extent by the lands above The Pas.

Pasquia Reclamation Project. Saskatchewan River. Looking up from month of Little river.

Pasquia Reclamation Project. Saskatchewan River. Lake expansion to north. 23 miles below The Pas.

According to Dr. Klotz's scale of distances it is 76 miles from The Pas to Cedar Lake Post, but a careful scaling of his plan indicates but 72 miles. This is by way of the main Saskatchewan, while the distance by way of the Summerberry river is generally accepted as 13 miles farther. The first point at which the Saskatchewan breaks away from its main channel is at a point 4¾ miles below The Pas where 'the Little River' is formed. This is the regular steamboat channel, except at very low water, and affords an excellent short cut returning to the main channel at mile 15½. The next offshoot is the Summerberry, which leaves the main channel at a point about 18½ miles below The Pas and, after approaching to within about four miles of Moose lake, turns to the south and joining its waters with another offshoot from the parent stream, flows into Cedar lake some miles north of the point at which the main channel enters.

About two miles below the head of the Summerberry river there is a point known locally as the Wooden Tent. The water is very shallow here except for a narrow channel on the north side, and the bottom is hard and strewn with boulders. In low water there is a rapid here and some work may be necessary at this point, but it is so near the western boundary of the area sought to be drained as to make it somewhat doubtful as to the advantages to be derived from such work.

There is more rock and hard bottom at the foot of Hill island, about 38 miles below The Pas, at the Frying Pan and at a point 3½ miles above Cedar lake. There is also a slight rapid opposite Poplar point called the Poplar Point rapid, but none of these rapids are noticeable except at low water.

Erosion due to increased velocity caused by lowering Cedar lake will have little effect at these points and it will be necessary to do some excavating, but the depth and amount of such excavation cannot be determined until a survey and profile of the river be made.

The usual delta formation exists at the approach of the river to Cedar lake, and out of the numerous channels already in existence it will be necessary to choose the one best suited to afford an outlet for all the waters discharged by the river, having in view the requirements of navigation as well as drainage.

Moose Lake.

Moose lake is a large lake of very deep bays, and Moose Lake Post at the south end of the lake is about forty miles north from Cedar Lake Post.

The south end of Moose lake is only about 6 miles from the north arm of Cedar lake, but the two lakes are not connected at this point. In Mr. Ogilvie's 1911 report he states that there are two outlets to Moose lake, one of which is through the Sturgeon river, but Mr. Lamb, of Moose lake, informs me that such is not the case. The Sturgeon river takes its rise in a muskeg south of Moose lake and flows south into the north arm of Cedar lake.

The outlet of Moose lake is through Moose creek, which is less than one hundred feet wide and has a uniform depth of about fifteen feet. I saw no evidence of any rapid or hard bottom in this stream, but found a bar of mud in Moose lake just at the mouth of the creek on which the water was only two feet in depth at the time of my visit. Moose creek is four miles in length and joins Moose lake with the Summerberry river. At periods of low water Moose lake empties into the Summerberry through this creek but during high water the procedure is reversed and the Summerberry empties a considerable portion of its waters into Moose lake. The waters of the Summerberry are heavily charged with silt which is held in suspension by the rapid motion of the water, but contact with the still waters of the lake causes the precipitation of the silt and the formation of the mud bar mentioned above.

This bar is a menace to navigation and might be avoided by the construction of a short canal on one side with a gate at the south end. It is unlikely, however, that the Moose Lake route will be much used after construction work on the Hudson's Bay

railway is completed. At the present time this route is used to take supplies, etc., through to Cormorant lake. It is also used in the Moose lake fishing trade and by the Hudson's Bay Company.

The lowering of Cedar lake would probably put a stop to the backflow into Moose lake, and thus prevent the formation of the bar.

It is not known at present whether it is necessary or not to lower the waters of Moose lake in order to drain the surrounding lands. It might be an advantage to confine the flow from Moose lake to periods of low water. This regulation of the flow would not only be a great advantage to drainage but could be made of still greater value in the proposed power development at Grand rapids by storing the water in Moose lake and its feeders, Cormorant and Clearwater lakes, for use in winter when the discharge of the Saskatchewan is but half the normal. Cross lake and Cedar lake would also be available for storage after the period of highest water had passed.

Elevations.

On September 12, 1911, a geodetic survey was completed connecting Stephen, Minn., U.S.A., with Winnipeg Beach on lake Winnipeg, and a board gauge placed on the south side of the Government wharf there. The elevation of the zero of this gauge was found to be 712·16 above sea-level and the elevation of the surface of the water was 715·06.

During the month of September and the first thirteen days of October, 1912, a record of the readings on this gauge was kept by the Public Works Department, and during the same period a record of the readings on a gauge at the mouth of the Saskatchewan river, near Grand rapids, was kept by the Manitoba Hydrographic Survey. The readings at Winnipeg Beach vary greatly from day to day and seem to be seriously affected by wave movements, so that it is difficult to make comparisons between the two gauges.

A careful comparison of the two sets of readings, however, shows two periods which seem to be influenced by similar conditions. The first period from the 7th to the 10th September, inclusive, at Winnipeg Beach seems to correspond to the period from the 6th to the 9th of September, inclusive, at Grand rapids. During the period 7th to 10th September the mean of the gauge readings at Winnipeg Beach was 4·05 feet, while during the period 6th to 9th of September at Grand rapids the mean of the reading was ·60 feet. From this it will be seen that:—

Zero of gauge at Winnipeg Beach is	712·16
Mean of gauge readings at Winnipeg Beach (September 7 to 10)	4·05
Elevation of surface of lake Winnipeg	716·21
Mean of gauge readings at Grand rapids, September 6 to 9	·60
Zero of gauge at Grand rapids	715·61

This period is chosen because the variations in the gauge readings seem to be somewhat similar. There is a condition of high water at the north end of the lake and low water at the south end on September 5 and 6. This indicates a south wind apparently extending over the entire length of the lake, but extreme low water did not occur at the south end until September 6, whereas extreme high water at the north end occurred on September 5—a difference of one day. For these reasons I have compared the period 6th, 7th, 8th and 9th at Grand Rapids with the period 7th, 8th, 9th and 10th at Winnipeg Beach.

The gauge readings at Winnipeg Beach were so uniform as to indicate a comparative calm, while there seems to have been a slight local disturbance at Grand rapids.

The second period for comparison is September 16, 17 and 18 at Winnipeg Beach and September 17, 18 and 19 at Grand rapids. The gauge reading at Winnipeg Beach

on September 17 was the mean of the three daily readings, and the gauge stood at 3·70 feet. On September 18 the gauge at Grand rapids read ·51 feet which was the mean for the period under consideration. Applying these results as in the first period we have:—

Zero of gauge at Winnipeg Beach	712·16
Gauge reading at Winnipeg Beach, September 17	3·70
Elevation surface lake Winnipeg at Winnipeg Beach, September 17, and Grand rapids, September 18	715·86
Gauge reading at Grand rapids, September 18	·51
Zero of gauge at Grand rapids	715·35

During this period the variations were very similar, following a storm at the south end.

The average of all the gauge readings at Winnipeg Beach for September and the first thirteen days of October, 1912, compared with the average at Grand rapids for the same period is as follows:—

Zero of gauge at Winnipeg Beach (geodetic survey)	712·16
Average of 41 gauge readings at Winnipeg Beach	4·03
Average elevation of surface of lake Winnipeg during the period.	716·19
Average of 41 gauge readings at Grand rapids	·69
Zero of gauge at Grand rapids	715·50

Recapitulation.

Zero of gauge at Grand rapids, based on observation during first period	715·61
Zero of gauge at Grand Rapids, based on observation during second period	715·35
Mean of the two determinations	715·48
Zero of gauge at Grand rapids based on average of 41 readings	715·50

From these considerations I am led to adopt 715·50 as the elevation of the zero of the gauge at Grand rapids instead of 711·43, as assumed by Mr. Patterson. The average surface elevation of lake Winnipeg for the 41 days under consideration was 716·19, while the mean elevation for the two periods cited above was 716·03.

I have therefore decided to take 716 feet above sea-level as the elevation of the surface of lake Winnipeg during September and the first half of October, 1912.

The year 1912 was a high-water year, but not as high as 1908. Extreme high water at The Pas was about two feet higher in 1912 than in 1911. This would mean a variation of about one foot or less at lake Winnipeg, which would make the elevation of lake Winnipeg 715 feet in 1911. This accords with the elevation determined by the Geodetic Survey in that year. As 1911 was a year of little more than average elevations, I adopted 715 feet above sea-level as the average elevation of the surface of lake Winnipeg. This agrees with Mr. Ogilvie's views, as expressed in his 1911 report.

A careful survey of the river between lake Winnipeg and Cross lake made by Mr. E. B. Patterson for the Manitoba Hydrographic Survey, in 1912, shows the difference in elevation of these two lakes to be 105 feet, which makes the elevation of Cross lake 820 feet.

Mr. Ogilvie, in his 1911 report, gives the difference of elevation of Cross lake and Cedar lake at 15 feet, and the elevation of Winnipegosis as the same as Cedar lake. This would give an elevation of 835 for Cedar lake and Winnipegosis.

The elevation of the zero of the gauge placed by the Public Works Department on the upstream side of the boat landing at The Pas is given as 845·45. The reading on this gauge at extreme high water in 1912 was 13·6, which makes the maximum elevation of the water at The Pas during the year 1912, 859·05 The maximum for 1911 was 856·90.

The best information at present available would seem to indicate the following elevations:—

Location.	Elevation, 1911.	Elevation, 1912.
Lake Winnipeg	715	715
Cross lake	820	821
Cedar lake	835	836
Lake Winnipegosis	835	836
Moose lake	846	846
Clearwater lake	860	860
The Pas	857	859

The elevation of Moose lake and Clearwater lake were taken from White's book of Altitudes, while the elevations at The Pas are taken from the gauge heights recorded by the Public Works Department for the years given.

From this table it will be seen that the fall between The Pas and Cedar lake is about 23 feet during high water. The distance is about 75 miles, according to the plan of Dr. Klotz, but the fall practically all occurs in a distance of 72 miles, and may be taken at ·31 feet per mile. This agrees very closely with Mr. Ogilvie's determination of the fall, although his elevations are considerably different from those given herein. In low water the fall would be somewhat less as the water rises and falls through a much greater range at The Pas than at Cedar lake. Between October 15 and November 30, 1912, the surface of Cedar lake fell 2 feet while, during the same length of time but three weeks earlier in the season, the surface of the river at The Pas fell slightly more than 6 feet. If, then, we consider that during the high-water period the water at Cedar lake remained at a comparatively uniform elevation and by November 1 had only fallen about 1½ feet, while on the same date at The Pas it was 6 feet lower than it was during nearly the whole of September, it is apparent that the probable fall between The Pas and Cedar lake on November 1, 1912, was only 18½ feet, and it might even be less than this at times.

Since the elevation here given for Cedar lake depends on a different survey altogether from the elevation given for The Pas, the conclusions drawn from these elevations must be considered as a rough approximation.

Discharge.

Very little is as yet known regarding the discharge of the Saskatchewan river at The Pas. In the year 1909, Mr. Forward, acting for the Public Works Department, made a measurement by means of floats, and found the discharge to be 25,210 second feet. From this he estimated the discharge at maximum flow to be 105,000 feet per second.

In 1911, the Department of Public Works had two meterings taken and found the discharge to be 42,637 second feet on August 9, and 23,177 on September 29.

On October 22, 1912, a metering was made for the Manitoba Hydrographic Survey, in which the discharge was found to be 38,122 feet per second. Using the

cross-section given, it is possible to form a rough idea of the discharge at other gauge heights. From this it appears that the maximum discharge for 1912 was about 76,000 second feet, and in 1908 it must have been about 105,000 second feet, as given by Mr. Forward.

It does not appear that any measurements have ever been made between The Pas and Grand Rapids.

In 1910, Mr. Ogilvie made a metering at the head of Grand rapids, and, acting under your instructions, the Manitoba Hydrographic Survey had three meterings made in 1912 at the station established by Mr. Ogilvie in 1910. From the information thus obtained, a fairly complete curve has been worked out. Drawing on this information, I find that the discharge at the maximum gauge height during the period of observation in 1912 was 67,950 second feet, and the minimum 31,720 second feet.

This shows a considerably greater maximum discharge at The Pas than at Grand Rapids, which was to be expected from the extensive storage facilities afforded by the lakes and flooded area between the two points. On the pletion of any efficient scheme of drainage, however, this difference in discharge between The Pas and Grand Rapids would almost entirely disappear.

The available information regarding gauge heights and discharge of the Saskatchewan river below the Forks is very meagre, and it is important that metering stations be established and a daily record of gauge heights be kept at several points between the Forks and Grand Rapids. In addition to the stations at Grand Rapids and The Pas, there should be at least three others established, viz., one below the Forks, one at the Sipanok channel and one near the Narrows. With a series of meterings and a record of daily gauge readings at these five stations, the information regarding discharge, storage, etc., at different stages of water would be fairly complete. This information is absolutely necessary to permit of an intelligent solution of the problems involved in the proposed scheme.

The Plans.

The plans accompanying this report were compiled from the best information obtainable at the present time. The plan of part of Cedar lake and Cross lake was prepared from notes of our 1912 survey, which was hurriedly made, and is not intended to be more than a rough approximation except the lower half mile of the river and Cross lake, which was more carefully done and is fairly accurate.

The basis of the field plan was Mr. Ogilvie's plan accompanying his report of 1911. Some alterations and numerous additions have been made to this plan, but no attempt is made to correct the location of Cross lake, which is slightly out of position on the map. Much of the information regarding small lakes and islands distant from the Saskatchewan river has been gleaned from conversations with Mr. Lamb, of Moose Creek, and other residents. The elevation of the different lakes was determined, as explained in this report.

THE DRAINAGE SCHEME.

As has been suggested elsewhere in this report, the key to the drainage scheme is the link between Cedar lake and Cross lake. Either the river must be deepened between these two lakes sufficiently to lower Cedar lake the required amount, or an independent route for a canal must be found, or a combination of these two schemes.

In attempting to determine the most feasible and economical route for this canal, there are so many unknown factors to be dealt with that it renders the problem quite impossible of solution at present. While it is not possible to fix the location of this canal nor to design it in detail with the information at hand, it is quite safe to discuss its requirements and, in a general way, some of the features that will affect the location.

From the discharge measurements taken at the Pas it seems very probable that in the years 1901 and 1908 there was, for a short time at least, in the neighbourhood of 100,000 second feet passing this point, while at Grand Rapids the maximum discharge was probably over 70,000 second feet. Mr. Forward estimated the maximum discharge at Grand Rapids to be 66,684 second feet, but this is less than the actual discharge found by Mr. Patterson in 1912, when the flow was considerably less than the maximum.

No measurements have been made of the discharge between Cedar and Cross lakes, but it may be assumed to be the same as at Grand Rapids, without material error.

Such a flood as this would, under the present conditions, turn the whole country between the ridge on which The Pas stands and Cedar lake into an immense lake which would continue to rise until the discharge at The Pas had subsided to 70,000 second feet.

As soon as the flood at The Pas decreased below 70,000 second feet the waters would begin to recede from the flooded area. In any drainage scheme designed to confine these waters to the bed of the Saskatchewan at such an elevation as to prevent any flooding of the drainage basin the channel between Cedar lake and Cross lake would require to have a capacity of at least 100,000 second feet without raising the surface at Cedar lake above an elevation of 824 feet, or four feet above Cross lake. We can hardly hope to accomplish this by any improvement in the river alone, as there is not in all cases sufficient width to accommodate this water within the velocity limit prescribed by this restricted fall of four feet between the two lakes. The most economical scheme would seem to be a low-water canal capable of discharging about 50,000 second feet, and which, reaching its capacity, would overflow into the river, which should be deepened the required amount at the Cedar lake end. Such a canal would require to be about 1,200 feet wide and 10 feet deep at Cross lake, with a fall of 1·44 feet in 10,000.

It would be better to construct the canal with a cross-section of say 900 feet in width for the lower 6 feet in depth, and widening the portion above this to give the desired capacity. This would preserve the depth in the canal at 6 feet during the spring and fall, and thus avoid shortening the season of navigation.

The canal should be constructed first and this would leave the bed of the river dry except in very high water. The unwatering of the river bed would greatly facilitate the work of excavation, as the current is so swift in the rapids as to render dredging operations difficult. It would only be necessary to deepen the upper end from the Narrows down to the foot of Flying Post rapids, and only to the width and depth actually shown to be necessary by experience after the construction of the canal.

There are five possible courses marked on the plan, of which the length and approximate yardage are as follows:—

					Yards.
A-B	the length is	24,000	feet, cubical content is	. . . . .	16,000,000
A-F	" "	30,600	" " "	. . . . .	16,300,000
A-E	" "	31,500	" " "	. . . . .	15,000,000
C-D	" "	24,000	" " "	. . . . .	14,120,000
C-F	" "	25,500	" " "	. . . . .	12,870,000

From this it will be seen that the most economical course will probably be found to be C-F, although this depends almost entirely on the proportion of rock encountered, which is at present an unknown quantity.

A rough idea of the cost may be obtained by taking 40 cents as the average cost of the excavation.

Before this work is completed, and the water let out of Cedar lake, it will be necessary to make a cut through the shoal at Rabbit point, and deepen the channel at Duncan island at the west end of Cedar lake. A deeper channel may possibly be found farther south from Rabbit point, as no soundings were taken there, but it is reported to be shallow.

No further details of this work can be given at present, nor of the work necessary to be done in the Saskatchewan river between Cedar lake and The Pas.

It will be found to be less expensive to deepen the river, wherever necessary, before the velocity of the water is increased by the lowering of Cedar lake. It might, however, be possible, during low water, to divert the greater portion of the flow to the Summerberry by means of a temporary dam at the forks of the Summerberry and thus unwater the main Saskatchewan, but this could not be done except in very low water, owing to the small capacity of the Summerberry channel.

Immediately following the lowering of the water in Cedar lake, the velocity in the Saskatchewan and Summerberry will be increased by an unknown and variable amount, probably two or three times its present velocity, which will cause considerable erosion, particularly in the vicinity of Cedar lake. After the bed of the river assumes its final form, the velocity of the water will be found to have increased about 25 per cent above the present velocity, and the power to transport silt will have increased about 75 per cent.

Owing to the absence of rock in the Summerberry channel it seems quite probable that, if left to itself, the river will eventually adopt this channel to the exclusion of all others. There are two things that will militate against this, and they are: First, the longer course, and second, the narrowness of the channel. The channel could be widened artificially but the cost would probably be greater than for deepening the main channel at the rapids between The Pas and Cedar lake. Another objection to the adoption of the Summerberry channel is that the main channel would soon become unnavigable.

SOILS.

During the season of 1912 very few samples of soil were taken owing to the prevalence of high water which prevented any examination of the soils of the interior. A few samples were secured in the vicinity of the Saskatchewan river, but no report as to their value has yet been received from the Dominion Chemist, and, in any case, they cannot be considered as representative of the interior soils.

In taking samples from the vicinity of the river, I felt I was simply repeating what had been done by Mr. Ogilvie in 1911, without adding materially to the information already gained.

So far as can be determined at present the soils of the district between The Pas and Cedar lake are practically all alluvial, having been formed by the precipitation of the sediment carried down by the river. As has been said before, the waters of the Saskatchewan are very heavily charged with silt, especially during the flood period. When the river overflows, the water rushes away into the interior lakes and marshes, and the silt, which has been held in suspension while the water was in motion, settles to the bottom and leaves the water comparatively clear, except for the colouring due to the presence of vegetation. As the flood recedes, this deposit is left on the land, and the operation is repeated at the next overflow.

The water gradually clears on its course down stream resulting in the inevitable shoals and bars in the river, but the greatest precipitation takes place when the back water from Cedar lake is reached. After passing through Cedar lake and the 6-mile link of the river between Cedar and Cross lakes, the water is found to be comparatively free from sediment. In the northern extensions of Cedar and Cross lakes the water is of crystalline clearness and purity.

The certain result of this periodical flooding must be that the coarser particles held in suspension by the water, being heavier, will be deposited in or near the river bed at the first slight diminution of the velocity, and only the very fine particles would be carried into the interior. This makes it especially desirable that samples be obtained at points remote from any channel of the Saskatchewan, past or present.

Pasquia Reclamation Project. Saskatchewan River. Showing Poplar shore line.

Pasquia Reclamation Project. Saskatchewan River. Showing Willow shore line flooded area in background.

In the year 1911 the late Mr. Ogilvie secured twenty-two samples of soils in this section and had them analyzed by Mr. Shutt, Dominion Chemist. While Mr. Shutt's report on these soils is quite favourable, an intimate knowledge of the district from which the samples were taken is necessary to an intelligent understanding of the situation. For instance, sample No. 33 is from a very high stony ridge nearly one hundred feet above the water, as stated in Mr. Ogilvie's report of 1911. Samples Nos. 32 and 38 are from high ground more or less stony and above the reach of high water. The evidence presented by these three samples should carry very little weight, as the areas they represent are very limited, and bear no resemblance to the great flooded area. The remainder of the samples are practically all from near the river, and fairly represent the soils along the banks. These, however, are certainly dissimilar and probably inferior to the soils of the interior. Samples from the interior can be obtained only with the greatest difficulty owing, as stated above, to the presence of water, and it may be necessary to use a specially constructed instrument for this purpose. It would probably be less difficult in seasons of very low water.

In all cases where the water is not too deep, there is a very rank growth of grass, while in the wetter portions rushes and some coarser varieties of grass extend as far as the eye can reach. The growth seems to indicate a fertile soil, the absence of trees being easily accounted for by the continuous presence of water at or above the surface of the ground.

NAVIGATION.

The navigation of the lower Saskatchewan river has been confined to boats of about 3 feet draught, and there is no attempt to go farther down than Cedar lake. In the days before the construction of the Canadian Pacific railway, the river was navigated all the way to the head of Grand rapids by York boats and even steamboats, which were hauled up the Red Rock and upper rapids by means of a line. Freight of all kinds intended for the west was unloaded at the foot of Grand rapids by boats plying on lake Winnipeg. From here it was transferred to the head of the rapids by means of a tramway, using horse-drawn cars.

Should the power at Grand rapids be developed and locks constructed, lake Winnipeg vessels could pass the rapids and ascend the river to Cross lake. The power dam at Grand rapids should be of such height as to flood out Red Rock rapids completely, and so reduce the fall in Cross Lake rapids as to admit of easy navigation without raising the elevation of Cross lake.

The construction of the proposed drainage canal between Cross lake and Cedar lake will reduce the fall between these lakes from 15 feet to about 4 feet. This fall would produce a current of about 3 miles per hour and should not present serious difficulty to navigation for the short run of five miles to Cedar lake.

When the shoals at Rabbit point and Duncan island have been removed, as recommended herein, there will be no obstruction to navigation across Cedar lake. The only vessels running from The Pas to Cedar lake at present are those of the Ross Navigation Company, and the only business is the carrying of supplies to Cedar Lake post. The direct route from The Pas to Cedar lake is by way of the main Saskatchewan, but, as the volume of business at Cedar lake is very small, the trip is generally made by way of the Summerberry channel to Moose lake and thence to Cedar Lake post, returning by the direct route.

In the winter there is a small trading settlement at Pine Bluff and a smaller one at Hill island, but one trip in the fall is all that is necessary to supply these. There is also a little trading done in the winter time at Poplar point, but this is south of the main Saskatchewan and is supplied from Cedar Lake post.

At the present time the route by way of the Summerberry channel is more important than by the main channel, since the bulk of the trade is to Moose lake and through Moose lake to Cormorant lake. The trade to Cormorant lake will be cut off, however.

on the completion of that portion of the Hudson Bay railway from The Pas to this lake. The only white settlement in the district at present is at The Pas. On the completion of the drainage works and the opening up of the large area to the south for settlement, the navigation of the main Saskatchewan will become most important, and the cutting out of the rapids mentioned elsewhere in this report will distribute the fall along the whole course between Cedar lake and The Pas, and will improve the navigation of this channel very materially.

Thus, with the development of the power at Grand rapids and the construction of drainage works proposed in this report, little else will be required to make the Saskatchewan navigable from The Pas to lake Winnipeg. The only additional expense required will be the construction of locks at Grand rapids and raising the dam high enough to flood Red Rock and Cross Lake rapids. It may be found that a lock will be necessary at Cross Lake rapids and, if so, this may be very readily constructed on the north side.

It will, of course, be advisable to keep a dredge in the river for the removal of any small bars that may form from time to time at the west end of Cedar lake.

These bars are at present a menace to navigation as are also some of the other shoals in low water.

CLIMATE.

A daily record was kept of the readings of the thermometer and barometer during the months of August, September and October, as follows:—

TEMPERATURE AND BAROMETRIC READINGS.

Date.	Temperature.		Barometer.		Remarks.
1912.	Max.	Min.	A.M.	P.M.	
August 2	73	54	30·15	30·09	
" 3	77	53	30·25	29·91	Fair.
" 4	74	54	29·91	29·97	Fair.
" 5	75	52	29·72	29·85	Cloudy.
" 6	74	46	29·79	29·79	Cloudy and rain.
" 7	71	51	29·80	29·81	Cloudy and fog.
" 8	76	52	29·95	29·91	Fog; fine.
" 9	75	54	29·83	29·91	Fair.
" 10	80	55	29·80	29·65	Fair.
" 11	76	53	29·53	29·52	Rain.
" 12	77	55	29·60	29·70	Rain and cold
" 13	70	50	29·74	29·51	Cloudy and cold.
" 14	72	57	29·71	29·70	Fair and cold.
" 15	76	54	29·79	29·65	Fair and cold.
" 16	76	58	29·10	29·81	Cloudy.
" 17	74	57	29·85	29·91	Cloudy.
" 18	76	50	29·87	29·81	Fair.
" 19	78	51	29·91	29·87	Cloudy.
" 20	78	52	29·95	29·70	Cloudy.
" 21	68	50	29·62	29·60	Rain.
" 22	78	51	29·75	29·76	Cloudy and cold.
" 23	79	49	29·75	29·56	Cloudy and cold.
" 24	70	47	29·39	29·70	Rain.
" 25	76	48	29·72	29·70	Rain and cold.
" 26	67	42	29·36	29·92	Cloudy.
" 27	69	43	29·43	29·91	Cloudy.
" 28	66	46	29·95	29·93	Rain.
" 29	62	41	29·77	29·55	Rain.
" 30	67	53	29·54	29·62	Rain.
" 31	57	50	29·33	29·42	Cloudy.
Sept. 1	67	45	29·51	29·62	Rain.
" 2	70	46	29·79	29·85	Fine.
" 3	73	47	29·81	29·75	Rain.
" 4	73	46	29·79	29·85	Rain.
" 5	72	52	29·75	29·50	Rain and gales.
" 6	67	53	29·75	29·70	Rain and gales.
" 7	69	49	29·85	29·74	Fine.
" 8	68	49	29·75	29·79	Fine.
" 9	69	50	29·74	29·74	Fine.
" 10	70	53	29·80	29·79	Fine.
" 11	72	54	29·10	29·25	Fine.
" 12	76	54	29·31	29·00	Fine; rain.
" 13	74	53	29·62	29·82	Rain and gales.
" 14	70	52	29·30	29·74	Rain and gales.
" 15	66	52	29·45	29·45	Fair and cold.
" 16	65	33	29·10	29·25	Cloudy and cold.
" 17	66	34	29·25	29·25	Cloudy and cold.
" 18	63	40	29·70	29·90	Fine; rain.
" 19	64	41	29·21	29·00	Rain and gales.
" 20	64	40	29·50	29·85	Rain and gales.
" 21	66	39	29·10	29·35	Rain and gales.
" 22	66	41	29·45	29·30	Rain and snow.
" 23	57	30	29·91	29·90	Snow flurries.
" 24	56	25	29·25	29·10	Cloudy and cold.
" 25	57	26	29·20	29·15	Fine.
" 26	54	24	29·10	29·95	Snow flurries.
" 27	44	30	29·10	29·25	Rain and snow.
" 28	47	25	29·45	29·40	Cold and windy.
" 29	54	25	29·05	29·32	Fair and cold.
" 30	57	30	29·00	28·85	Fair and cold.

TEMPERATURE AND BAROMETRIC READINGS—*Concluded.*

Date. 1912.	Temperature. Max.	Min.	Barometer. A. M.	P. M.	Remarks.
Oct. 1	60	36	28·75	28·50	Cloudy and rain.
" 2	64	37	28·40	28·45	Fair and mild.
" 3	60	41	28·50	28·40	Cloudy and cold.
" 4	61	40	28·50	28·57	Cold; rain.
" 5	49	37	29·10	29·15	Cold; rain.
" 6	47	31	29·15	29·00	Cloudy and cold.
" 7	51	34	28·70	28·70	Cloudy, rain.
" 8	48	35	28·75	28·95	Rain and snow.
" 9	48	30	29·25	29·12	Cloudy and cold.
" 10	43	26	28·91	28·87	Cloudy and cold.
" 11	40	34	29·00	28·80	Fine.
" 12	47	33	29·15	29·10	Cloudy and gales.
" 13	54	24	28·75	28·60	Cloudy and cold.
" 14	55	37	28·82	28·80	Fair and cold.
" 15	50	32	29·10	28·95	Fair and mild.
" 16	46	31	29·00	28·70	Fair and mild.
" 17	49	33	28·80	28·82	Cloudy and cold.
" 18	47	36	28·81	28·85	Light snow.
" 19	45	35	29·00	28·80	Fair
" 20	41	33	28·75	28·75	Snow, 3 inches.
" 21	41	28	28·70	28·80	Fair and cold.
" 22	40	25	29·15	29·00	Fair and cold.
" 23	38	25	28·32	28·82	Fair and milder.
" 24	39	28	28·41	28·63	
" 25	47	29	29·15	28·90	

Fine is intended to mean clear.
Fair is intended to mean partly cloudy.

The following summary shows the highest and lowest readings and the average temperatures for each month, together with the number of times the mercury fell below the freezing point:—

August—

Highest readings on 10th	80°
Lowest readings on 26th	42°
Average maximum	73°·5
" minimum	49°·3
Number of times below 32°	None.

September—

Highest reading on 5th	78°
Lowest reading on 26th	21°
Average maximum	62°·2
" minimum	40°·9
Number of times below 32°	9

October (1st to 25th)—

Highest reading on 2nd	64°
Lowest reading on 13th	24°
Average maximum	48°·5
" minimum	32°·3
Number of times below 32°	11

The first light snow flurry was on September 22, but no snow to speak of fell until October 20, when there was a fall of three inches which remained on the ground for several days. The weather throughout the season was unusually cool and wet.

ASTRONOMICAL.

No instruments for precise determinations of latitude or longitude were included in our outfit, as these were not considered necessary. The approximate location of the different points visited seemed to be all that was required.

The main points in the district were all located by Mr. Ogilvie in 1911, except Cross lake. I made approximate determinations at The Pas Forks, Cedar Lake Post and at Cross lake, which were the only points at which the sky was sufficiently clear for making observations. It was not very satisfactory at Cedar lake on account of clouds. In every case the meridian was determined by observing Polaris, but the watch correction was found by both sun and star observations.

The point of observation on Cross lake was at the foot of Demi Charge rapid on the north shore. The latitude of this point was found to be 53° 10' 24" and the longitude 99° 42' 13" W.

No correction was made for the rate of the watch, as it showed practically no variation during the first ten days at Cross Lake camp, although changing considerably later.

The declination of the needle was found, from a number of observations taken at Cross Lake camp, to average 17° 40' east.

The location of the west arm of Moose lake has been determined by the 15th Base Line which has been run under the Surveyor General's instructions eastward from the second meridian to intersect the lake. Other lines have been started and are being extended across the district this winter, and these will give a definite location to all points not already determined.

All of which is respectfully submitted.

THOS. H. DUNN, *C.E., O.L.S.*
Engineer in Charge.

Dated at Ottawa, this 7th day of March, 1913.

EXTRACTS FROM REPORT OF WM. OGILVIE, D.L.S., ON THE PASQUIA RECLAMATION PROJECT, SEASON 1911.

To J. B. CHALLIES, Esq.,
Supt. Water Power Branch,
Department of the Interior.

SIR,—I have the honour to submit for your information and consideration the following report on my investigation of the Swamps, or as they are sometimes called 'the drowned lands' on the lower Saskatchewan river, during the season of 1911.

ITINERARY.

I immediately on receipt of my instructions dated June 16, 1911, began preparations for my departure in the way of procuring the required instruments and appliances. This was completed on the 24th, and I left Ottawa for Winnipeg on the evening of the 25th going by way of the lakes.

Mr. Ogilvie reached The Pas on July 11th and started up the Pasquia river on July 31st. He took observations at The Forks and sent exploring parties up the east and west branches to collect soil samples. He found this river to be fed principally by the Pasquia hills which are forty miles from the town of The Pas and about 1,200 feet in height above the surrounding plains to the north and east.

In speaking of the derivation of the word 'Pas,' Mr. Ogilvie found it to be an abreviation of the word 'Pasquia,' meaning 'The place where two hills meet,' and, in this connection, says in part:—

'On the south side of the Saskatchewan and east of the Pas river is a gravel ridge running southerly and parallel with the latter stream for about 25 miles, gradually declining into a peat bog. This ridge at The Pas rises from thirty to thirty-five feet above the river and as it is only about a mile wide and the surface bordering it is barely above river level this ridge from a distance is quite prominent. On the north side of the river a similar ridge exists, but somewhat higher. It is locally known as "The Ridge."

'It is part of an Indian reserve and the houses on top of it can be seen, at open places, from miles above it on the river. These ridges do not abut one another on the river, the northerly one being about two miles above the southerly, but viewed coming down stream, especially from the lake marked on our maps "Reeder Lake," these ridges or hills seem to meet, and this is probably the origin of the name as it was generally explained to me.'

Returning from the Pasquia river he next ascended the Carrot river to the mouth of the Sepanok channel and thence up the Sepanok to the Saskatchewan river. From here he went through a "cut-off" to the Torch river which he followed to Cumberland lake and thence back to The Pas.

He found that the upper reaches of the Sepanok Channel pass through comparatively high ground and it is only at times of high water that the Saskatchewan flows through this channel to the Carrot river. At other times the water is so low

in the Sepanok as to be insufficient for the passage of even small canoes. Two or three small log jams were encountered in the Sepanok. The Saskatchewan broke away from its confines in 1872 and found a new channel for a portion of its waters by way of the Torch river to Cumberland lake. In this new channel the greater part of the fall was found to be in the first few miles after leaving the main Saskatchewan, which resulted in considerable flooding and a division into many channels in the vicinity of Cumberland lake.

The Pas was reached on September 1st and the start made down the Saskatchewan on September 11th. About 25 miles below The Pas two lakes were examined and an opening connecting the river with the lake on the south side was found to be much enlarged since 1910. Above the opening this lake was found to be separated from the river by a bank averaging about 100 yards in width. The various river channels in the neighbourhood of Cedar lake were examined and Cedar Lake Post reached on September 22nd. High winds caused delay at the Post and High Portage was not reached until September 29th. A line of levels was run over the portage from Cedar lake to Lake Winnipegosis. A compass survey, in which the courses were paced, was also made of the portage road. Moose lake was next visited and the return to The Pas accomplished on October 25th.

AREA OF SUBMERGED LANDS ON THE LOWER SASKATCHEWAN.

(Copied from report).

'For convenience of reference it is necessary that everything and locality have a name, and custom demanding that such be as brief as is consistent with sense, I will take the liberty in this report of calling this tract the 'Pasquia Reclamation Area.' As I have remarked in my reference to this tract, in 1910 it was at one time undoubtedly the bed of a shallow lake on the course of the Saskatchewan river just as Cedar, Cross, Winnipeg, and other lakes farther down are now on the Saskatchewan and Nelson, and as Cumberland lake soon will be if the Saskatchewan is not diverted from the old cut-off channel of 1872, and later that of 1908 or 1909, which I have referred to. The bounds of the Pasquia Reclamation follows are the bounds of this old lake. To trace these bounds was the fo ject of my expedition in 1911. This lake had not sharp declivities for shore the task of determining with the ordinary degree of precision its limits is practically impossible.. On the south side this is notably so; on the north the rise from the confines of the present submerged lands is much more marked, but this is mainly due to a general change of geological character. It might I think be correctly stated that the south bound of the wide spread Laurentian area of the north is the north bound of these submerged lands so far as it is adjacent to it. True, some differences will be found, but this condition I think will hold generally.

As I stated in my 1910 report, a person going down the Saskatchewan river from any point near the Forks sees high banks ranging from twenty to fifty feet, and behind these terraces rising to the height of the great prairie and wooded plains which are more than one hundred feet above the level of the river. At the h... of the Sepanok channel this condition suddenly changes and the banks fall from one to six feet, and a marked characteristic of these low banks is that on leaving the ri w they fall away into low swampy land which is covered with a thick growth of grass and willows, with frequent clumps of balsam, poplar, and cottonwood, and an occasion.. area of higher ground covered with upland timber, smooth barked poplar, spruce and balsam.. This falling away of the banks is a very pronounced characteristic of the region until Cedar lake is reached, when the ordinary conditions obtain again. The origin of this natural dyke or levee, along the river is caused by a channel being cut by the flowing waters

from the original lake higher up. The shallower waters bordering the deeper flowing one had little or no current, and so sediment brought down by the current when it happened to be thrown out into the quiet water dropped. This accumulating, formed a bank or bar on which grass soon started, willows, and later on poplar, and other timber peculiar to the country took root, flourished in the rich damp soil and formed an obstruction to the overflow of the water to such an extent that sediment was not carried past it as abundantly as in the freer flowing waters of the river, and the bank was gradually raised to such a height that only at exceptionally high water was it overflowed. The sediment deposited on this bank was of course the coarsest part held in admixture by the river water, and so in the main was more sandy and gravelly than that carried past through the barrier of trees, shrubs and grass. The finer parts consisting of dissolved lime, clay and vegetable matter were carried on and only deposited in calm or comparatively calm water. It follows as a general rule that the soils immediately along the river are coarser and more sandy than those deposited farther away from it. In fact at some points where the conformation of the bank was favourable I have seen bars of fine sand, while only a short distance back from the river the fine silt peculiar to alluvial deposits was found.

The south boundary of this old lake would at one point at least appear to have been close to the Prince Albert branch of the Canadian Northern railway. At Hudson Bay Junction there is a gravel ridge which is evidently an old beach. A few rods north of the line of railroad it falls away to a flat covered with rather large poplar, which continues along the railroad for ten miles where a further decline begins, swampy in character, and covered with stunted spruce and tamarack. The timber and shrubbery give evidence of growing on a frozen swamp, the frost being preserved by a covering of moss, which drainage will dry up, kill, and leave the surface ready for firing. At twenty-six and a half miles a creek is crossed and bordering it the timber improves in size and character. Between 30 and 31 miles from Hudson Bay Junction we enter a higher surface with good poplar trees bordering a large creek. At thirty-four and one-eighth miles is a small river in swampy ground, but the soil in the river bed looks good. At fifty-one miles what I think is the south-east branch of The Pas river is crossed. The banks show two or three feet of muck, or peat, which is underlaid by good looking soil. Near the bank where this soil is exposed the vegetable growth is good, and in marked contrast to that a few rods away on the peaty surface. The surface soon falls again, or changes, for it is so level on all this branch that only with an instrument could one detect the inclines, and continues low and swampy, in some places boggy till we reach sixty-five and a half miles from the junction when the ground gradually rises into a gravelly ridge which continues to The Pas, eighty-nine and one-fourth miles from Hudson Bay Junction. The timber on this ridge is small, but this apparently is the result of forest fires, keeping it limited in growth. The shrubbery indicates good growing qualities. Strawberries at the date of my arrival, July 11, were plentiful and of good size and quality. Other small fruits flourish in season.

It is alleged by old timers that the native Indians tell how on one or two occasions excessively high water in the Saskatchewan flowed over a low boggy part of the railway line about twenty-six miles out from The Pas and across country into Lake Winnipegosis. All I could learn about this was that some old natives had said so. I did learn, however, for a fact that the water has been so high that steamboats have sailed in a direct line from The Pas to Cumberland House and also from The Pas up the Carrot valley to Sheal lake near the foot of the Pasquia mountains. I have no doubt at all of the truth of these statements. When I reached The Pas July 11th, the water in the Saskatchewan was rather above ordinary level, not extraordinary at all, yet it was rushing up the Pas river at a rate much exceeding the flow of that stream when its waters flow in the natural direction. This seemed very strange to me until I went up The Pas and saw the extensive areas of low land bordering that stream. Along the lower reaches there are several lakes and as these

had been drained pretty well by the unusually low water of the previous season it took some time to fill them again when the Saskatchewan rose to its ordinary height. On the Pas river the same dyke-like banks are to be found as have been described on the Saskatchewan. These lakes are shallow, not more than four to six feet deep and the bottom soil is, as might be anticipated, of a rich character. The first lake is only about three miles up by the meandering course of the river, and less than two overland, but overland is an uncertain term in this vicinity and has one meaning in low water, and another in high. A person having seen the outward flow from the Saskatchewan up The Pas can easily believe that there were times when the Saskatchewan waters would flow across to Lake Winnipegosis, for the course of the Pas river, ascending is not far from the line of the Canadian Northern railroad which follows the gravel ridge I have already referred to on the south side of the Saskatchewan. In passing over this road glimpses westward can occasionally be caught through the forest, and immediately bordering the ridge are the meadow, marshland, and lakes bordering the Pas river. About twenty miles out the ridge falls away and the bog I have already referred to would seem to permit the flow of very high water over it. As the country is fairly open, and a long view can be had eastward, nothing in sight would indicate hindrance to this overflow once past the railway. Fifteen to twenty miles from Hudson Bay Junction, the timber to the westward of the track is thin and stunted, through and over which can be seen the Pasquia mountains not more than ten miles away and the surface is apparently the same all the way to the mountains, low, flat and marshy. It is covered with a growth of moss which probably preserves the frost in the undersoil, and accounts for the stunted state of the forest. At the lake I have mentioned about twenty-four miles below The Pas a distant view is had southward and southeastward across it, but no rise is visible.

At Chemihawin (Cedar lake) I met some natives who are familiar with the country around. They had been pretty well over the "Rat country" as it is locally called; that is the low swampy parts in which muskrats abound. The pelts of these little animals constitute the great bulk of the furs caught here, and so the natives are very dependant on them for a living and visit in turn every part of the region in which they flourish which is the region I wished to find the bounds of. Westward from Chemihawin, Mud lake extends for about five miles. This lake is of the same character as all the others in the submerged area, shallow with muddy bottom. In low water it is difficult to navigate even in canoes by reason of its shallowness. Westward from it a few miles the Hudson Bay Company keeps a winter trading post at a place known as 'Poplar Point.' I received at Chemihawin reliable information to the fact that the natives in times of high water in the river make their way in canoes from 'Poplar Point' to The Pas in a direct line by traversing a series of ponds and lakes, which dot the country. From this route, except at one point the river is never in sight. This gives a good idea of what all the surface in this low, flat region is like. Some of the Indians told me that they had often hunted in the winter as far south as the borders of Red Deer lake which lies only three or four miles north of the Canadian Northern railway and discharges through a stream only eight or ten miles long into Lake Winnipegosis. This demonstrates that the swamp belt extends as I have previously intimated to the vicinity of the Prince Albert branch of the Canadian Northern railway. Others told me they had been eastward from The Pas branch of the road a short distance out from the Junction and found swampiness the prevailing condition. Following this information I have laid down the south bounds of the swamp lands on my map. At Chemihawin I learned from the Indians that there is a winter portage from the arm of Cedar lake just south of that point across the neck of land between Lakes Cedar and Winnipegosis. This portage is said to be about the same length as High Portage which is a little under four and a half miles. It is all too low and wet to be travelled over in summer time, except a short distance at the south end on the bank of Lake Winnipegosis where there is a sandy ridge timbered with jack pine (Pinus Banksiana). I was told

that the character of the surface along Mossy Portage, which is ten or twelve miles eastward from this along the south shore of Cedar lake, is much the same with the same sudden dip down to Lake Winnipegosis. As there is shown from report of two of the portages between those lakes, and a survey and level of the third, a sudden and very pronounced dip down to Winnipegosis; all of whom I inquired were emphatic in their contention that Cedar lake was much higher than Winnipegosis. I found both lakes practically on the same level as I will prove later on. The reason for the illusion as to the difference of level is that the ground on High Portage rises very gradually from Cedar lake and drops suddenly to Winnepegosis in a distance of 800 feet from an altitude of 92 feet above Cedar lake. To the inexperienced eye a rise of 20 or 25 feet in a mile is inappreciable, while a drop of 92 feet in less than a sixth of a mile would be very apparent.

The peculiarity of low, flat banks all along the south shore of Cedar lake and high banks on the north shore of Winnipegosis would seem to indicate that there always was a division between these two bodies of water, even when Cedar Lake was a part of the large lake which occupied the valley of the Saskatchewan. This same high bank continues around to the Saskatchewan river about midway between Cedar and Cross lakes where it apparently has an abrupt ending. No doubt it at one time continued past this but the river wore it away and lowered its bed to the present elevation. Around the lower and narrow part of Cedar lake the south shore is rocky and abrupt rising generally eight to twelve feet above the water, but sometimes twenty or thirty. Near the narrows this abrupt character falls away from the lake to appear on the river below as I have stated above.

The beach along the north side of Cedar lake, as far as I saw, is low, and while it cannot be called swampy along the shore, I gather from information acquired, that is its general character in the peninsula between the main body of the lake and its narrow arm at the lower end. A native who frequents the region around the lower end of the lake and has been much north of it gave me notes of a river which he said flowed into the bay running northward from the extreme east end of the narrows. This stream he said he often ascended on hunting expeditions. He informed me its waters were comparatively sluggish for about two days paddling, and as he always hunted on his way, I would not allow more than fifteen miles a day which would give us say thirty miles of comparatively easy water; this being no doubt crooked would not prove more than twenty to twenty-five in a straight line.

At the north end of this comparatively slack water the surface changes from a low and generally swampy character into sandy ridges timbered with Jack Pine and some poplar. This characteristic continues as far north and east as my informant had travelled, which must have brought him to the vicinity of the north-east arm of Moose lake.

About the land around Moose lake to the north and eastward Mr. William McKenzie, whom I have previously mentioned, gave me, I think, reliable information, and revised the map I showed him, a copy of the Departmental map on a scale of 12½ miles to the inch. In a word Mr. McKenzie characterized the country north and east of the lake as mixed in character, many gravel and sand ridges, with swamps intervening, timbered with, gen[illegible]y stunted spruce and tamarack. The ridges as a rule bear the Jack Pine and poplar of the country. He thinks that the swamps could be easily drained into the lake, but as to their elevation relative to the lake he could say nothing. He gave me sketches of lakes and streams hitherto uncharted which will appear on my [illegible] and so need no further reference here. He gave me some information about Lake Weknsko. This name is pronounced by the natives with the accent strongly on the first syllable which is sounded as though written "Wake." His information was that the name is the equivalent in Indian of "Peppermint," which plant abounds on the shores of the lake, so much, Mr. McKenzie said, that its odor becomes oppressive at times. He spoke of it as being much larger than any he has seen elsewhere in this region, and it is very common all over the low lands and

continues down the Nelson river, though less commonly to Bladder Rapids if not farther. Lake Kekusko is called by many whites "Weed" lake, no doubt because of the incapability of the natives met with by them to give any other meaning of their native name in English.

Mr. Lamb, who has been mentioned, gave me a good deal of information covering the surrounding country both agriculturally and geographically. His sketch of the eastern shore of the north arm of Cedar lake, locally called "Clear lake" from the clearness of its water as compared with that in the main body, differs a good deal from that shown on our maps. But as on the map furnished me this shore is indicated by a dotted line, denoting uncertainty, I presume Mr. Lamb's delineation is as reliable as that shown on any map extant. He had not been much on the eastern and northern parts of Moose lake except on that arm extending toward Cormorant lake, but with that part lying between Cedar or "Clear" lake and Cormorant and Atikameg lakes he was pretty well acquainted, having gone over it on hunting and trading excursions. He describes this tract as marshy in general character with ridges covered with spruce, jack pine and poplar traversing it in various directions. As to the nature of the soil in the swampy parts, he was unable to say anything, his journeys being made in the winter. The timber on the ridges he considered fairly good when compared with the general run of timber in our north land. I may say that ridges timbered with more or less valuable lumber are a characteristic of this swamp area. In many instances these ridges consist of the limestone rock peculiar to all this region close to the Laurentian area. Wherever I have seen them they bear poplar and spruce, the latter often of commercial size. Sometimes jack pine is found on them but not often. The agricultural qualities of these ridges I will speak of when discussing the qualities of the soil of the whole area.

Mr. Lamb gave me some notes about the stages of the water during his sojourn in the Moose lake vicinity:

In 1900 he was drowned out and could not secure hay enough for his needs. In 1901 and 1902 the water was very high again. This recurrence of floods caused him much loss in animals and damped his ardour as a cattle raiser. The water again flooded the surrounding flats in 1906, but 1908 was the banner season for high water. In that year Mr. Lamb assured me the floods rose two feet over the floor of the ice house at Moose lake, from which it follows that all the low area must have been flooded. That season he could not get any winter fodder for his stock and so had to slaughter every head. Raising grain so far from means to convert it into the ordinary forms of food would be futile, it has not been attempted. Cattle are raised successfully at all four posts in this area, Cumberland, The Pas, Chemihawin, and Moose lake. Grand Rapids at the mouth of the Saskatchewan is so close to the district that it also may be included, and here too cattle are raised successfully. Mr. Lamb ventured into this business because good nutritious hay abounded in his vicinity, but conditions were against him. This gentleman while he did not know any more of the nature of my mission than what he might infer from rumours in the district, was most enthusiastic in his views of its possibilities if it could only be drained. In this event he would arrange to farm where he is and take his marketable produce to the Hudson Bay Railway by steamer to The Pas. An alternative route would be via Moose lake to Frog river and up it to the railway, but as there are several rapids on this small stream, this would involve team hauling for some miles. Then too, lowering Cedar lake would also lower Moose lake to such an extent that it might not be navigable to Frog river. In any event it seems to me the Saskatchewan route would prove most economical and convenient.

This comprises all the prominent authentic evidence I got relating to the boundary of the submerged area. I heard a good deal more but it was not so direct or positive as that I have quoted. I saw a good deal myself in parts, and have deduced from all I saw and heard a position for the limits of the submerged area which I have marked by a dotted red line on the map of the area, on a scale of six (6) miles to an

inch, which I herewith submit. This line will, I think, be found not very far in any place from the true location when final and complete surveys are made. Outside the red line I have laid down a dotted blue one, which according to observation and information includes areas that while not as a rule submerged, are so sometimes, and will be greatly benefitted by such drainage as will reclaim the lower lands.

In concluding this subject, I will say I have carefully measured by planimeter the area within the red line shown on my map, and find it as follows:

Area in square inches..	215·70
Hence in square miles..	7,765·20
Townships..	215·7
Acres..	4,969,728·

The area between the red line and blue one is:

Square inches	69·1
Hence in square miles..	2,487·6
Townships..	69·1
Acres..	1,592,064.
Combined area in square inches..	284·8
Hence in square miles..	10,252·8
Townships..	284·8
Acres	6,561,792·

CHARACTER OF THE SOIL IN THE DROWNED AREA

That I might have positive evidence in this matter I gathered samples of soil and subsoil at numerous places during the progress of my examination. These were brought to Ottawa and submitted to the Dominion Chemist Mr. Frank T. Shutt, M.A., for examination as to their fitness for farming purposes. It was agreed between us, that this examination would not be of a high chemical class, as to constituents, and their relative amounts, but only of an approximate nature solely with relation to their value for agricultural purposes, notes of which Mr. Shutt would furnish me with for each sample, and also submit a short general report on the whole series. The notes are here inserted followed by the report. I will make such remarks on each sample from the viewpoint of local knowledge, as I deem advisable, and in many cases such remarks are very necessary, for this reason: At not a few localities the only place possible to obtain a specimen was close to the river, the surface a few rods back being covered with water, as I have already shown, and at others while it was not water covered it was peaty to below the water level too far for us with an ordinary spade to bring up a fair sample, and so it came that some of the specimens are more sandy in character than a more representative specimen, I am confident, would have proved, and in some cases more peatty than the true soil under the peat surface would have proved. When I have good reason to qualify Mr. Shutt's remarks in this connection I will do so, by an explanatory note, preceding his remarks on each sample. One dominant feature pervaded the whole area, except at a few very limited places and that was a luxurious growth of hay, weeds, shrubs and timber. At a few places where the character of the soil was sandy an abundant growth of a tall grass flourished. There is no local name for this product, and as the only name I heard for it, 'rushes', was so inappropriate and misleading, as it is not at all rush-like either in appearance or constitution, I ventured after consultation with our veteran botanist, John Macoun, to call it 'bamboo grass,' as it bears a strong resemblance to that tree. I may add the botanical name is 'Phragmites Communis.' It often attains a height of ten feet or more and the stock of such a specimen would at the ground be nearly if not quite half an inch thick. It is very stiff and flinty in nature, breaking almost as sharply as a rod of glass of the same thickness would. I do not know of any use to which it

could be put, being too hard and brittle for food except the extreme top, and even that cattle do not seem to care for. However, it is so isolated in occurrence, and so limited in area that even if it were valuable it could hardly be counted as an asset. I have dwelt on it so much, for the information of scientific people who may find in it some climatic indication. I may say I have never seen it on or near our more northern streams.

Here follows Mr. Shutt's notes on the specimens of soil submitted to him. I may explain that the letters and figures Laby No. 10840 and sequence are for laboratory number 10840, that is the recorded number of the specimens as received at the Dominion Chemical Laboratory. The following number is my own in the order of succession of taking. The description of and reference to locality are my own notes, following which are Mr. Shutt's findings and conclusions:—

CENTRAL EXPERIMENTAL FARM,
OTTAWA, February 20, 1912.

REPORT ON SOIL SAMPLES FROM THE REGION OF THE LOWER SASKATCHEWAN DISTRICT OF THE PAS, MANITOBA.

(Submitted by Mr. William Ogilvie.)

Laby No. 10840.—'No. 1 Depth 15"; collected 11-8-11, grass 2 feet 5 inches; about 15 miles up Carrot river; poplar and willow, good hay. Essentially a clay, but containing a considerable proportion of silt and fine sand; friable when dry; rich in vegetable matter which, however, is somewhat peaty and not well decomposed. Vegetable matter mixed rather than incorporated with the clay and sand. Stratification of sample furnishes evidence of alluvial deposition. Reaction, very slightly alkaline; available lime, good indications.

Laby No. 10841.—'No. 1 subsoil.' Yellowish grey clay with little or no admixture of vegetable matter; dries into hard lumps.

Laby No. 10842.—'No. 2, depth 18"; collected 11-8-11; about 27 miles up Carrot river; poplar, willow and alder; much fine hay land.' Clay loam similar in general character to No. 1 surface, but of softer and finer texture, probably owing to the large proportion of fine sand; fairly well supplied with organic matter. Stratified structure; reaction, very slightly alkaline; available lime, indicated.

Laby No. 10843.—'No. 2 subsoil.' Essentially clay and sand; friable.

Laby No. 10844.—'No. 3, depth 24". Collected 12-8-11; about [illegible] miles up Carrot river. Essentially a mixture of peaty vegetable matter and clay; apparently an accumulation of peat on a silty alluvial deposit; reaction, very slightly alkaline; available lime, traces.

Laby No. 10845.—'No. 3 subsoil, clay, unknown depth.' Yellowish-grey clay with some fine sand; on exposure dries into hard masses.

Laby No. 10846.—'No. 4. About 10 miles below Sepanok channel on Carrot river; collected 13-8-11; 1 mile above Finger's upper camp:' A clay loam with but little vegetable matter; containing a few small shells; stratified structure; dries into rather hard lumps. Reaction, decidedly alkaline; available lime, heavy traces.

Laby No. 10847.—'No. 4 Subsoil.' Clay with some fine sand; friable when dry.

Laby No. 10848.—'No. 5, taken at Junction of Sepanok channel and Carrot river; collected 16-8-11.' Clay loam with some fine sand and silt; considerable amount of vegetable matter; a good piece for an agricultural soil.

Laby No. 10849.—'No. 5 Subsoil, one foot down.' Clay and silt with some fine sand; friable when dry.

Laby No. 10850.—'No. 5 Subsoil, two feet down.' Largely silt with a considerable proportion of sand.

Laby No. 10851.—'No. 5 A, Subsoil three feet down.' Chiefly clay with some sand.

Laby No. 10852.—'No. 5 B, Subsoil, four feet down.' Largely fine sand with some silt and clay.

Laby No. 10853.—'No. 5 C, Subsoil five feet down.' Largely fine sand with some silt and clay. Essentially clay; dries on exposure into hard masses.

Laby No. 10855.—'No. 6, about 4 miles up Carrot river from Junction with Sepanok channel.' Chiefly clay and silt with a considerable admixture of vegetable matter, but very little sand.

Laby No. 10856.—'No. 7, depth 6', about half through Sepanok channel; collected 19.8.11; birch, willow, poplar, spruce.' A yellowish-brown light, sandy loam; sand fine grained; very friable; well supplied with organic matter; would consider it would make a good arable soil.

Laby No. 10857.—'No. 7, Subsoil two feet down.' Light grey fine-grained sand.

Laby No. 10858.—'No. 8, about ¾ through Sepanok channel; 10 inches; collected 21.8.11; poplar, willow, alder.' Grey loam, consisting largely of fine sand, but some clay and silt; rather poor in vegetable matter; would probably make a fair agricultural soil. Reaction very faintly alkaline:, available lime, faint traces.

Laby No. 10859.—'No. 8 Subsoil.' Fine sand with little silt;

Laby No. 10860.—'No. 9. About 1½ miles down Sepanok channel from Saskatchewan river. Collected 23.8.11. Willow, poplar.' Grey sand, fine grained; very little clay or silt and very poor in vegetable matter, probably too light and thin for good arable soil. Reaction—very faintly alkaline. Available lime—considerable.

Laby No. 10861.—'No. 10. About ½ mile from Saskatchewan river on Sepanok channel.' A light loam consisting of silt and fine sand with a fair amount of vegetable matter; physical condition good; should make a good soil on tillage. Reaction—slightly alkaline. Available lime—very heavy traces.

Laby No. 10862.—'No. 10. Subsoil.' Grey; rather course grained sand; practically no clay or silt.

Laby No. 10863.—'No. 11. At junction of Saskatchewan with Sturgeon (Torch) river. Collected 24.8.11; poplar, willow, alder.' Greyish loam; clay and silt with fair proportion of fine sand and some vegetable matter; friable. Reaction—slightly alkaline. Available lime—very heavy traces.

Laby No. 10864.—'No. 12. About 7 miles up Torch river. Depth 20". This sample was taken from the edge of a marsh meadow about where the shore line of the original lake was. From here up the Torch river, the land rises, and as we are near the southern limit of the Laurentian area the prevailing character of the soil is sandy, that is as far as I saw it, and as far as information I gathered also proves. I have no doubt therefore, that this sample came from the vicinity of the beach of the Ancient lake where one would naturally expect to find sand if any were to be found in the vicinity. Brown or black fibrous peaty material with some root fibre; essentially crumbling when dry; a little fine sand.

Laby No. 10865.—'No. 12. Subsoil.' A fine grained sand with very little cementing material and some vegetable matter.

Laby No. 10866.—'No. 13, from separation of old Torch river channel by a new break in bank; Lat. 53° 57' 38"; high course grass; sandy soil, "bamboo grass" (*Phragmites Communis*) 5 ft. to 8 ft. high.' A fine grained sand with very little clay; very loose and open; a little root fibre; would be considered distinctly poor. Reaction—slightly alkaline; available lime—slight traces. In this case the sample was taken from a sandy spot covered with 'bamboo grass' (*Phragmites Communis*) to which I have already referred. The area from which it came is very limited so it can not in any way be considered representative of even a fraction of the whole.

Laby No. 10867.—'No. 13. Subsoil.' Very similar to No. 13, surface soil, but with a little more clay and probably less vegetable matter.

Laby No. 10868.—'No. 14, from island in extensive lagoon five miles north of camp. Collected 25-8-11; depth 10 inches; grass and willow.' Brown sandy loam; friable; plenty of vegetable matter fairly well decomposed. Though distinctly light, should make a very fair soil. Reaction, practically neutral. Available lime, traces. This sample was taken from one of the ridges or islands which I have mentioned as being common in the low area, and may be considered characteristic of the soil of most of them.

Laby No. 10869.—'No. 14 Subsoil.' Gravel and sand with some fairly well decomposed organic matter.

Laby No. 10870.—'No. 15. Cumberland House; alluvial flats, grass; 28-8-11.' A grey loam essentially clay; a very small proportion of fine sand; a little vegetable matter; dried into rather hard masses. Available lime, traces.

Laby No. 10871.—'No. 15 Subsoil.' Clay; practically no sand or vegetable matter; dries into extremely hard masses.

Laby No. 10872.—'No. 16. On bank of Saskatchewan river, 2½ miles below Tearing river; willow, poplar, alder.' A grey sandy loam; a little clay and silt; fair amount of vegetable matter; sand extremely fine-grained; a light loam of loose and open texture. Reaction, slightly alkaline; available lime, traces.

Laby No. 10873.—'No. 16 Subsoil.' A fine-grained grey sand; very similar to surface No. 16, but with practically no vegetable matter.

Laby No. 10874.—'No. 17, Cumberland House.' A dark grey loam, very sandy but with sufficient clay and silt to lightly cement the particles. Well supplied with vegetable matter which, however, is rather peaty; should make a good loam with tillage. Reaction, alkaline. Available lime, heavy traces.

Laby No. 10875.—'No. 17. Subsoil. A course gravel made up of stones and fragments of rock, many of which strongly effervesce on the addition of acid owing to the presence of carbonate of lime.

Laby No. 10876.—'No. 18. About 8 miles above Big Bend on Saskatchewan river.' Note by Mr. Ogilvie taken from bank of river, so not a fair sample. A light grey very fine sand, traces only of clay and silt; very loose and porous and probably poor in humus. Reaction, alkaline; available lime, light traces

Laby No. 10877.—'No. 18 Subsoil.' A fine-grained pale yellow or greyish sand, with a very little clay or silt; small proportion of vegetable matter.

Laby No. 10878.—'No. 19. Bank of Saskatchewan 8 or 9 miles below Big Bend; collected 30-8-11; willow, alder, poplar.' Note by Mr. Ogilvie taken from bank of river, hardly a fair sample. A silty sand showing some tenacity; a little vegetable matter; alluvial deposition indicated; should make a very fair soil. Reaction, alkaline; available lime, slight traces.

Laby No. 10879.—'No. 19. Subsoil.' A tenacious clay; refractory when dry; small proportion of sand and some little vegetable matter.

Laby No. 10880.—'No. 20. Depth 15 inches; collected 31.8.11; from bank of Saskatchewan at upper entrance to Reeder lake; grass 1-3 ft.' A sandy loam with little clay and silt; fair amount of vegetable matter; evidently requires drainage; should make a fair soil; reaction—alkaline. Available lime—heavy traces.

Laby No. 10881.—'No. 20. Subsoil.' Heavy tenacious clay; refractory when dry; small percentage of fine sand; practically no vegetable matter.

Laby No. 10882.—'No. 21. Bank of Saskatchewan a mile above Big Eddy; fine hay land; extensive meadow; depth 10 inches; collected 1.9.11.' (Grass 2 ft.-3 ft. high.) This sample was taken from just under the grass roots so contains much peaty matter. The soil mixed by cultivation with some of the subsoil ought to make good agricultural land. The growth of hay on it is excellent. Essentially vegetable matter which is decomposed, peaty and fibrous; a little clay present. Reaction, alkaline; available lime, light.

Laby No. 10883.—'No. 21. Subsoil.' Clay with a little fine sand; dries into hard masses; a little vegetable matter present.

Laby No. 10884.—'No. 22. Bank of Saskatchewan near Big lake about 19 miles below The Pas.' A loam in which clay and silt predominate with a very considerable amount of fairly well decomposed vegetable matter; friable; should make a good soil. Reaction, alkaline; available lime, heavy.

Laby No. 10885.—'No. 22. Subsoil.' Clay, very similar to subsoil No. 21.

Laby No. 10886.—'No. 23. Near Saskatchewan river about 18 miles below The Pas, on north side. Depth 4 feet. Collected 12.9.11; willow, poplar, alder.' Essentially vegetable mould, decidedly peaty with some fine sand. Reaction, alkaline; available lime, light traces.

Laby No. 10887.—'No. 23. Subsoil.' A fine sand with some silt and vegetable matter.

Laby No. 10888.—'No. 24. From north side of Big lake about 19 miles below The Pas, collected 16.9.11; poplar, willow.' A stiff clay loam, with a very fair proportion of sand and some vegetable matter. Reaction, slightly alkaline; available lime, very light.

Laby No. 10889.—'No. 24. Subsoil.' A marly clay, in white hard masses; very little sand; large proportion of carbonate of lime present.

Laby No. 10890.—'No. 25. South side of Big lake 19 or 20 miles from The Pas. Collected 16.9.11. Vegetable mould 6 inches, clay 8 inches, then water. Owing to the prevalence of water here it was impossible with my appliances to get anything like a representative sample of the soil, the surface soil falling to the bottom of the cut. Judging from the vegetable growth I would say, that when drained and worked it will be good farm land. Very peaty and fibrous in character with practically no clay or sand.

Laby No. 10891.—'No. 25 Subsoil. (Willow, few spruce, tamarac and poplar).' Marly clay, very large proportion of carbonate of lime.

Laby No. 10892.—'No. 26. Same locality; marsh land.' A clay loam with large proportion of vegetable matter; should make good soil with tillage. Reaction, slightly alkaline; available lime, light traces.

Laby No. 10893.—'No. 26 Subsoil.' Similar to surface soil No. 26, but with much less vegetable matter.

Laby No. 10894.—'No. 27. Bank of Saskatchewan, 34 miles below The Pas. Collected 18.9.11; alder, willow, marsh grass.' Yellowish brown loam, light and friable; essentially sand but with some silt and clay; a fair amount of vegetable matter. Reaction, slightly alkaline; available lime, traces.

Laby No. 10895.—'No. 27 Subsoil.' A greyish yellow sand with a little silt and clay.

Laby No. 10896.—'No. 28. Bank of Saskatchewan about 55 miles below The Pas.' A stiff plastic clay; dries into hard masses; very little vegetable matter. Reaction, slightly alkaline; available lime, very slight traces.

Laby No. 10897.—'No. 29. Bank of Saskatchewan near Cedar lake, collected 19.9.11; willow; alder, some frost.' A stiff clay loam with considerable amount of semi-decomposed vegetable matter; small proportion of fine sand; dries into hard masses. Reaction, slightly alkaline; available lime, slight traces.

Laby No. 10898.—'No. 29 Subsoil.' Similar to surface soil No. 29, but with less vegetable matter.

Laby No. 10899.—'No. 30. Bank of Saskatchewan; Moose Lake Branch; collected 20.9.11. Largely vegetable mould, but with some sand, clay and silt; friable; should make a good loam with tillage. Reaction, alkaline; available lime, good traces.

Laby 10900.—'No. 30. Subsoil. A yellowish grey clay with a very little sand; dried into rather hard masses.

Laby No. 10901.—'No. 31. From limestone ridge on bank of Moose lake; or Summerberry river near Cedar lake; birch, willow, poplar, alder; some spruce.' A dark brown sandy loam with a large percentage of semi-decomposed vegetable matter; fine and friable. Reaction, slightly alkaline; available lime, faint traces.

Laby No. 10902.—'No. 31. Subsoil.' Sandy and very similar to surface soil No. 31, but with less vegetable matter.

Laby No. 10903. 'No. 32. From Hudson Bay Company's post, Cedar lake; spruce, willow, alder, tak-am.' A sandy loam with small proportion of clay and silt; fairly well supplied with vegetable mould and plenty of root fibre. Reaction, alkaline; available lime, heavy traces.

Laby No. 10904.—'No. 32. Subsoil.' About one-half rock fragments and pebbles, the remainder a sandy loam well supplied with organic matter; very rich in carbonate of lime.

Laby No. 10905.—'No. 33. From High Portage between lake Winnipegosis and Cedar. High gravel bridge; swamps on both sides.' A very coarse grained, loosely cemented sand with a certain proportion of vegetable mould and a little silt; crumbles readily when dry; would be considered a poor soil. Reaction, alkaline; available lime, very faint traces.

Laby No. 10906.—'No. 33. Subsoil.' Consists largely of stones and pebbles; incrusted with carbonate of lime.

Laby No. 10907.—'No. 34. From High Portage; Cedar lake end; depth, 6 inches; collected 4.10.11; grass 1 foot to 2 feet. A dark grey sandy loam with a large amount of peaty matter, but little clay or silt. Reaction, alkaline; available lime, good traces.

Laby No. 10908.—'No. 34. Subsoil. A light grey clay quite hard when dry, with pebbles which effervesce strongly with acid; very rich in carbonate of lime.

Laby No. 10909.—'No. 35. From near Cedar Lake Post (Chemihawin), collected 9-10-11; depth, 4 inches; grass 2 feet.' A sandy loam with large amount of peaty or vegetable mould and a little clay; should make a fair soil on cultivation. Reaction, alkaline; available lime, heavy traces.

Laby No. 10910.—'No. 35. Subsoil.' A light greyish clay with stones; contains a large amount of carbonate of lime.

Laby No. 10911.—'No. 36. From junction of Saskatchewan and Head rivers; collected 10-10-11; willow.' Note by Mr. Ogilvie, taken from bank of river, so hardly a representative sample. A very loose sand intermixed with some fine peaty matter; very little clay or silt; would be considered rather poor and leachy soil. Reaction, distinctly alkaline; available lime, traces.

Laby No. 10912.—'No. 37. From bank of branch of Saskatchewan known as Summerberry river, about 3 miles below mouth of Moose Lake creek.' A clay loam drying into hard masses; contains a fair amount of peaty vegetable matter. Reaction, alkaline; available lime, heavy traces.

Laby No. 10913.—'No. 37 Subsoil.' A stiff plastic clay; extremely hard when dry.

Laby No. 10914.—'No. 38. High land near Hudson Bay Company's post at Moose lake; depth, 2 feet.' A clay loam with some peaty vegetable matter; fairly friable. Reaction, alkaline; available lime, heavy traces.

Laby No. 10915.—'No. 38 Subsoil.' Clay and silt with some very fine sand and a little organic matter; friable and crumbly.

Laby No. 10916.—'No. 39. From alluvial flats around Moose lake at Hudson Bay Company's post.' A light greyish clay loam with a few pebbles; fairly well supplied with vegetable matter; friable; effervesces strongly with acid showing abundance of carbonate of lime. Reaction, alkaline; available lime, traces.

Laby No. 10917.—'No. 39. Subsoil.' A greyish yellow clay with some pebbles; effervesces strongly with acid.

Laby No. 10918.—'No. 40. North bank of the Saskatchewan river about 2 miles above Moose Lake creek.' A clay loam with some silt and a little sand; large amount of vegetable debris. Reaction, alkaline; available lime, heavy traces.

Laby No. 10919.—'No. 40 Subsoil.' Essentially a fine sand, but with sufficient clay to cement the particles; practically no organic matter.

Laby No. 10920.—'No. 41. From Traders lake, north side.' A silty loam with considerable proportion of fine sand and vegetable debris; friable; should make a good soil. Reaction, alkaline; available lime, traces.

Laby No. 10921.—'No. 41 Subsoil.' A very fine grained sand; particles cemented with a little clay and silt.

Laby No. 10922.—'No. 42. From Summerberry river about 12 miles above Moose Lake creek.' A sandy loam containing fair amount of clay and silt and plenty of vegetable debris; should make a good soil. Reaction, alkaline; available lime, traces.

Laby No. 10923.—'No. 42. Subsoil.' Sand with chalk-like pebbles; effervesces strongly with acid.

Laby No. 11021.—'A centre of Pas Townsite; depth, 4 inches, 8 inches; surface gravelly; shallow soil; good grass and pasturage.' Black sandy loam with practically no clay; large amount of well decomposed vegetable matter; of the nature of a muck soil. Reaction, distinctly alkaline; available lime, heavy traces.

Laby No. 11022.—'A. Subsoil.' Light grey clay; effervesces strongly with acid, showing a considerable amount of carbonate of lime; very hard when dry.

Laby No. 11023.—'One mile up Sakatchewan river from Pas; depth, 20 inches: hay, 2 feet; good grass.' A greyish clay loam with fair amount of vegetable matter. Reaction, distinctly alkaline; available lime, traces.

Laby No. 11024.—'B. Subsoil.' A grey silty clay with very little sand; dries into hard masses.

Laby No. 11025.—'C. One mile south-west of The Pas; depth 12 inches to 14 inches; swamp land; marsh grass; collected 22-7-11.' Brown or black loam with considerable amount of fine sand; dries into very hard masses; contains fragments of carbonate of lime. Reaction, distinctly alkaline; available lime, traces.

Laby No. 11026.—'C. Subsoil.' A light grey clay containing fragments of limestone rock; extremely hard when dry.'

Laby No. 11127.—'D. One and a half miles south from The Pas on R.R. Depth of soil, 10 inches; gravely ridge; bush land; poplar spruce, willow; grass in open spots; good strawberries.' Essentially vegetable mould and root fibre with some silt, clay and fine sand; fairly friable. Reaction, distinctly alkaline; available lime, slight traces; effervesces strongly with acid.

Laby No. 11028.—'D Subsoil.' A light grey clay very hard and refractory when dry; effervesces strongly with acid.

Laby No. 11029.—'E. From clay flat at The Pas; depth, 2 feet, 3 feet; good grazing ground.' Yellowish-grey clay with a little fine sand; not rich in vegetable matter; very hard when dry. Reaction, distinctly alkaline; available lime, very light traces.

Laby No. 11030.—'E Subsoil.' Greyish-yellow clay; practically no organic matter; very hard when dry.

Laby No. 11031.—'F. From island 5 miles south of The Pas; depth, 20 inches; good grass.' Essentially vegetable mould; fibrous and somewhat peaty with a little fine sand. Reaction, alkaline; available lime, good traces.

Laby No. 11032.—'F Subsoil.' Yellowish-grey clay: practically no organic matter; dries into very hard masses.

Laby No. 11033.—'G. About 25 miles up the Pas river; depth, 14 inches; poplar and willow; grass good, 3 feet 5 inches high.' Black loamy peaty in character; large percentage of vegetable matter with sand and a little silt. Reaction, alkaline; available lime, very slight traces.

Laby No. 11034.—'G. Subsoil.' Yellowish grey clay; rather stiff and plastic; a little fine sand; practically no organic matter.

Laby No. 11035.—'H. Near forks of the Pas river; loam, 2 clay; 2 loam again; good grass.' A clay loam fine and friable; a favourable proportion of vegetable matter.

Laby No. 11036.—'H. Subsoil.' A reddish-grey sandy loam.

Laby No. 11037.—'I. From five and a half miles up southeast branch of The Pas from forks; depth 15 inches; willow, spruce, poplar; good grass; high lands.' Dark grey clay loam; friable; contains fragments of charcoal; well supplied with vegetable matter. Reaction, alkaline; available lime, light traces.

Laby No. 11038.—'I Subsoil.' Greyish clay; some leaf mould; dries into hard masses; effervesces strongly with acid.

Laby No. 11039.—'K. From forks of north-west branch of The Pas; about 10 miles above main forks; depth, 15 inches; grass, 2 feet, 3 inches.' A sandy loam with some silt and clay; well supplied with vegetable matter, chiefly of the character of leaf mould; should make a good soil. Reaction, alkaline; available lime, very heavy traces.

Laby No. 11040.—'K Subsoil.' A reddish-grey sand with a little clay; effervesces strongly with acid; good supply of vegetable matter.

Laby No. 11041.—'L. Near foot of Pasquia mountains about 25 miles up north-west branch of The Pas from main forks; depth, 15 inches; grass 3—4 feet, spruce. Essentially vegetable matter, peaty fibrous with a little sand and silt. Reaction, alkaline; available lime, good traces.

Laby No. 11042.—'L Subsoil.' Essentially clay and silt with a fair amount of vegetable mould.

Laby No. 11043.—'M. From near where 2nd meridian crosses Carrot river; depth, 18 inches; poplar and spruce. Essentially a vegetable mould, rather peaty with a basis of clay and silt; should make a good loam with tillage. Reaction, alkaline; available lime, heavy traces.

Laby No. 11044.—'M Subsoil. Fine sand with some silt and clay and a fair amount of vegetable matter.

(Sgd.) FRANK T. SHUTT,
Dominion Chemist.

CENTRAL EXPERIMENTAL FARM,

OTTAWA, March 2, 1912.

WILLIAM OGILVIE, Esq., D.L.S.,
Mackenzie Apartments,
Elgin street, Ottawa, Ont.

RE SOILS FROM LOWER SASKATCHEWAN, MAN.

DEAR SIR.—Enclosed herewith I beg to hand you my report on the series of soil samples collected in the district of the Lower Saskatchewan river (The Pas) and submitted by you for examination.

After an inspection of the samples and the careful noting of their general character and structure, the examination, in the larger number of instances, consisted simply in an approximate determination of the chief physical components (clay, sand, etc.) and a preliminary qualitative analysis for the purpose of ascertaining the presence of available lime.

Further and more extensive work, chemical and physical, would not have been possible on the larger number of the soils, owing to insufficiency of material, nor would such have been desirable from the fact that the collections, by force of circumstances, had not been made in accordance with the requirements for obtaining representative and satisfactory samples. It is hoped, however, the information given is of the nature desired, and that it will be found sufficiently explicit for your purposes.

The series includes many types of soils, ranging from heavy, plastic clays to loose, open sands, with some examples that are essentially peaty in character. In a few samples the percentage of carbonate of lime is such as to characterize the soil as calcareous. For the most part the sand is fine grained, and but few gravels were noticed.

Many of the samples show a well-marked stratified structure and the evidence is strong that the soils of this district, with the exception of the more peaty samples, are of alluvial origin.

Considered as a series from an area that has been subjected at times to inundation, I am of the opinion that the results of this investigation may be considered as quite satisfactory. The larger number of the samples, it is true, do not exhibit that desirable homogeneity so characteristic of the prairie type of soil, but must rather be considered as coarse mixtures or as assemblage of thin layers in which the vegetable matter, more or less fibrous, has not yet reached the most satisfactory stage of decomposition. Tillage and drainage would do much to improve their physical condition by bringing about the further humification of the organic matter and that intimate association of the several soil constituents—clay, sand and humus—which results in a fertile loam, a loam that is at once easy to work, well aerated, warm and retentive of moisture and manurial constituents. There are some plastic clays that would be found extremely hard to work at the outset, but drainage, careful culture and lining would vastly improve them. They should in the larger number of cases make strong soils, suitable for grass and wheat. Again, there are a few sands so exceedingly light and poor that their profitable cultivation is a matter of considerable doubt. The majority of the samples, however, appear to possess favourable proportions of the chief physical components (clay, sand and humus), and these should form loams of excellent quality, suitable for farm crops in general. In nearly every instance we obtained satisfactory evidence of the presence of available lime—a feature upon which I place considerable importance—and in no case did we find any marked acidity or sourness.

As already remarked a certain number of the samples are distinctly peaty; in a few cases clay and sand are practically absent. The agricultural value of areas covered with a peaty deposit is always a difficult matter to determine. Some peats are exceedingly difficult to reclaim, others lend themselves more or less readily to methods of improvement. Much will depend on the nature and depth of the deposit as well as on the possibility of efficient drainage. When the organic matter is fairly well decomposed, the drainage good and the subsoil can be mixed, as by ploughing, with the surface deposit, good soils can frequently be obtained in the course of a few years. Such soils often prove excellent for hay and potatoes, though they are not as a rule well suited for grain and fruit. Occasionally in the reclamation of peaty areas, and especially when the deposit is fibrous and deep, good results have followed the burning away of the first few inches of the deposit, but this preliminary step should be undertaken when the surface only is dry, or the fire may destroy all the vegetable matter and irretrievable damage effected.

I have the honour to be, sir,

Your obedient servant,

(Sgd.) FRANK T. SHUTT,

Dominion Chemist.

The general report by Mr. Shutt would indicate that his tests of the samples would show on the whole a satisfactory class of soil for general farming. I regret that I did not provide myself with better appliances for procuring samples, and also larger ones. I might also have done better by, at each station selecting surface and subsoil samples at three or four different spots a few rods apart and combining them as one sample. This would have proved more representative, for it is not

difficult to conceive, in sedimentary deposits, marked differences of character brought about through inequalities, or obstacles, in the bottom of the basin of deposit. Indeed in the vicinity of a flowing stream it is not difficult to imagine local changes established by a faster or slower current, in the first case carrying away the lighter sedimentary deposit, in the other dropping it.

On most of the places furnishing peaty samples there was a luxuriant growth of hay, long enough in stalk and thick enough in growth to yield from three to five tons per acre. Cattle and horses thrive well on this hay when cut in right season and properly cured. It is very probable that for several seasons after the water was let off, the land would be too wet for profitable grain, or root-growing. It does not follow, however, that the land would be valueless for that time, for its hay crop would, I think, pay as well as any other, as fodder would be required on the extensive public and other works following the drainage of the area, and there is nowhere in all the country where it could be so extensively and economically produced as here.

As Mr. Shutt in his report says, 'the vegetable and mineral constituents of the soil are not sufficiently mixed to constitute the highest class of soil, but this mixing can, and will no doubt be brought about by agricultural manipulation. There are bits of surface dotted over this wide expanse of low land in which agricultural operations could be started almost at once after the lowering of the water. This is notably the case on the Carrot river and Sepanok channel. The soil in this vicinity is considered by all who know it of the best, and certainly the vegetation bears out this estimation in the fullest sense. I have seen a good deal of our northwest and north, and at but few places have I seen an equal richness either in variety or quality of the flora generally. Of trees, both balsam, poplar (cottonwood) and ordinary poplar of large size abound. Spruce is plentiful in many places, and is generally of a superior quality for lumber making. Ash, elm, and what is locally called Manitoba maple *Acer Negundo*, abound along the banks of the streams at many places. The ash is seldom more than eight inches in diameter at the ground and thirty to forty feet high. The elm often attains a diameter of more than a foot, and a height of forty to fifty with a clean trunk long enough to give two lumber logs. The maple was always a good size for that tree, and at many places it was so plentiful along the bank that it might be said it was in groves. This was especially so on Torch river from the junction with the Saskatchewan as far up it as I went.

Of fruit trees, and shrubs, a few cherry trees were seen. High bush cranberries, 'Viburnum Pauciflorum,' were found everywhere, and the fruit was both plentiful and good in quality. Saskatoon berry trees, 'Amelanchiar Alnifolia' were common all over the area wherever the ground was dry enough to grow them. Raspberries were plentiful when the surface conditions were suitable. On the dry ridges, found so often in the area, strawberries were common, often abundant, and were of good size and flavour. The season for them was in 1911, nearly a month later than they ripen in Ontario, but I cannot say that is the rule. They abound particularly on the gravel ridges adjacent to The Pas. They might be found as abundantly at other places, but as the time for them was over when I left The Pas, they were not observed, to the same extent. Over a very large part of the submerged area, blue joint grass, 'Calamagrostis Canadenses,' abounds, and without any qualification it may be said it flourishes. I have seen it not less than seven feet high and so thick that it was difficult to make one's way through it. It is never, I think, less than two feet in length, and the average, I would place between two and three feet, nearer the latter, though. It constitutes the hay fodder for the winter sustenance of all the cattle and horses in the vicinity, and well serves the purpose. No attempt had been made recently, as far as I could learn, to grow grain, but Dr. Klotz in his report for 1884 speaks of wheat having been successfully grown at Cumberland House. As far as I could observe, or could learn, the summer temperatures were just as suitable for the development of the northern cereals as those of the rest of the Territory, which last word I use in the old sense. I learned from reliable authority that the yield of

all kinds of farm products along the middle reaches of the Carrot river is good, from which it may be inferred that there are not many serious climatic impediments to successful farming, for the difference in latitude is trifling, and the altitude and local conditions are very similar. At all the Hudson's Bay Company posts visited, Cumberland, The Pas, Cedar Lake, Moose Lake, and Grand Rapids, are gardens in which potatoes and household vegetables are grown. At all of those places there are Indian reserves in close proximity and many of the natives till small patches of ground and plant it with potatoes. Necessarily all agricultural operations are more or less crude, for their smallness in the case of white people precludes the idea of modern equipment, and poverty would in the case of the natives anyhow. Notwithstanding this the average quality of the potato crop is good. At all the places mentioned I bought potatoes, and such garden vegetables as were grown and developed enough for use, and found them good. Potatoes were bought from the Indians at Moose Lake, latitude 53° 43′, which were of good size and excellent quality. The natives, as far as I observed, made no attempt to grow anything else than potatoes, but the Hudson's Bay Company, at all points had a garden patch in which were grown the common garden vegetables, onions, beets, parsnips, carrots, cabbage and lettuce; these were at every place of good size and flavour. As all these garden plots were on the high ridges or islands which are so common in the low region, and the surface of these is either gravelly or rocky, they cannot strictly be considered an average test of the sedimentary soil of the low parts. If, however, these vegetables succeed on what we may correctly term the poorer grades of soil in the area we may predict, at least, as much success for any that will be grown on the richer alluvial soil of the lower lands, which with modern culture would no doubt prove all that is necessary.

All the clearings on those ridges outside of the cultivated patches grow a good growth of grass which makes, if one is to judge by the appearance of the cattle feeding on it, good pasturage. The lower lands, where dry enough, also furnish good pasturage. They would, however, be too soft for sheep, while the surface of the ridges and islands seem ideal for the support of that animal.

TIMBER.

Under this heading I can only repeat much of what I wrote in my report for 1910. The predominant tree is, as is the case all over our north-west, the poplar, in low ground the cottonwood 'Balsamea' abounding. Next in order of abundance is spruce. This tree is, it might be said, the only source of lumber in the north-west. It is not nearly as serviceable for that purpose as our eastern pine, or western fir, the trunks in the great majority of cases carrying limbs to such an extent that not more than one or two logs yielding fairly clear lumber can be cut from them. It is not so universally distributed as the poplar, which is found everywhere on all varieties and classes of soil. The spruce on the other hand is generally found in clumps and groves, apparently without much regard to the quality of the soil, except that it is seldom found in any numbers on sandy ridges, which are peculiarly the habitat of the white-barked poplar and jack pine. Our spruce is too limby to make good pulp wood. The poplar, however, for such pulp as it yields is fair for that purpose. Poplar and spruce constitute, I think, 90 per cent of the forest growth of the region, the other trees I have heretofore mentioned bearing a small ratio to the whole growth.

One feature of the forest growth which I dwelt on in my last year's report, as significant; I think is worth repeating here. I refer to the prevalence of our eastern balsam all over the area we are dealing with. This tree, though found pretty well all over the region, is not so abundant as to constitute even a small asset, apart from the theoretical one I submit. In our eastern forest, this tree is found associated with our pines, which heretofore constituted a large percentage of our forest wealth, though now the pulp wood spruce is dividing with them that distinction.

The conclusion I wish to draw from this association is that if they thrive together here, and the balsam is found nearly as abundantly, and quite as large in the north-west as here, it is not the fault of the north-west that the pine so common in the east is not found there too. It is, I think, a reasonable conclusion that our commercial pines of the east if tried in the north-west would naturalize in some parts and prove an important factor in the lumber wealth of the country. I would for the purpose of settling the suitability of our pines and other lumber trees, urge the establishment of a few tree nurseries at convenient points in the north-west. In my report of last year I suggest Norway House, on the Nelson river, and Fort McMurray on the lower Athabaska, as two points well suited for this purpose, both as to locality and climate. In addition to testing the suitability of our own trees there are foreign ones that it seems to me ought to do well in parts of our ultra prairie wilds. One of these, the Norway fir, 'Picea Excelsa,' and the larch, 'Larix Europa,' ought to naturalize well. These are both important trees in a commercial sense, and if they can be successfully transplanted to our north-west would prove immensely valuable. As their habitat in Europe is climatically similar to the region proposed to transfer them to, it seems reasonable to expect them to succeed with us. We have a representative of the larch in Canada, the hackmatack, or tamarack, 'Larix Americana,' but it is seldom found outside of swamps. In our eastern forests it attains a useful size, but in the swamps of the north-west, which are generally continually frozen to unknown depths they, like the other trees there, grow very slowly and never attain serviceable size. The difference between the size of a tree growing in ground which thaws during the summer, and one growing in a frozen swamp where less than a foot below the surface of the moss, frost to great depths is eternal, it might be said, is something which has to be seen to be realized. I have seen on the banks of the Yukon, open to the action of the sun's rays, and near the summer water at a temperature of 60 degrees or more Fahrenheit, trees upwards of twelve inches in diameter, whose growth rings showed them to be only 70 to 90 years old, while only a few rods away in the frozen swamps were trees of the same species three or four inches in diameter showing one hundred and fifty or more growth rings.

Drainage of those swamps would no doubt improve the conditions and promote the growth of a much larger tree in a much shorter time.

Before the discovery of bedrock mining in the Yukon, when surface gravel was all that was worked, the miners used to cut down the timber on the promising bank bars, and when dry enough fire it. This gave the sun a chance to dry the moss and penetrate to the frost below, melting it, so that in two or three seasons the ground could be worked. Drains cut through the moss and into the river or lower surface helped in reclaiming the ground. No doubt some similar process would convert many of our swamps into timber preserves, if not farm land.

These nurseries would be comparatively trifling in expense, and if as successful as we have good reason to expect, would mean billions of dollars added to the potential wealth of the country. There are large areas between the Saskatchewan and Churchill rivers that will never be valuable as agricultural land, and it is probable that a large percentage of these could be successfully utilized as forest reserves, which planted with good serviceable lumber trees, in accordance with the latest methods of forest planting, would prove of almost incalculable importance to the country in a couple of generations.

Many of those areas are swampy and so at present unfit for the growth of the trees mentioned, but I feel confident the drainage of a great deal of it would prove easy.

One thing is very evident—our northern forests do not yield per acre neither as good lumber nor as much of it as they ought. The main, in fact it might be said, the only source of lumber supply is our spruce, and it does not grow as universally in our forests as it might. That it might be more abundant is evident, for it thrives all

over our northwest and north. I have seen almost as large specimens of it in the Mackenzie river delta, latitude 67 degrees to 68 degrees, as I have ever seen, and all along the Yukon down to the Arctic Circle it is found in the valley bottoms and sheltered places, as plentifully and of about the same size as in the regions of the forests bounding our prairies.

There is no reason then why this tree should not abound more than it does except that it does not recover after forest fires as quickly as the poplar which in a few years after a devastating fire cover the ground almost as thickly as they can grow, while spruce takes ground more sparsely and more slowly. If our tree nurseries accomplished nothing else than a plentiful distribution of our spruce over our northern forests they would have justified their establishment. With that tree alone, selection and cultivation might so improve it as to produce practically a new species. What is possible in this direction the labours of Burbank and others show. So even though the transplanting of foreign lumber trees did not prove successful, we might with our own species accomplish so much as to amount to a new creation in our forest trees.

MINERAL INDICATIONS.

There are but few rock exposures along the river. I saw none south of it till the vicinity of Cedar lake was reached, when it crops out frequently. On the north side of the river exposures are more frequent. All that I saw is the magnesian limestone peculiar to the geological formation of the region, the Cambro-Silurian. In my report I refer to the probable use of this rock in making hydraulic cement in conjunction with the clays found near. It appears that the rock holds too much magnesia for good cement, but no doubt there will be found at a not inconvenient distance a purer limestone which mixed with the other will reduce the percentage of magnesia to a practically harmless quantity.

I could not learn of any analysis of any stone north of Cats Head on Lake Winnipeg, about half-way down it, having been made. Mr. J. Walter Wells, of the Mines Branch, in his preliminary report on the 'Limestones and Lime Industry of Manitoba,' 1905, deals pretty thoroughly with the matters named, and gives on page 53 an analysis of eight specimens from Lake Winnipeg. The average percentage of carbonate of lime for the lot is 76·68; the percentage of carbonate of magnesium, 12·31; of insoluble matter, 8·61; of alumina and iron oxides, 1·76. Moisture and sulphur trioxide amounts to less than one-half of one per cent. An analysis of a specimen from East Selkirk showed as follows:—

	Per Cent.
Lime carbonate	82·612
Magnesia carbonate	16·922
Ferric oxide and alumina	0·302
Silica dissolution	0·032
Insoluble matter	0·913

There would appear to be an excess of magnesia in all these for cement. It does not appear that there is any crystalline limestone in the Archæan rocks along the east shore of Lake Winnipeg, and whether or not any outcrops of it will be found in the same formation north and west of this region has to be learned. In any event, until some convenient and suitable form of fuel is found for burning, the question of fitness of the local limestones is not a prominent one. The coals of Alberta would no doubt make good enough coal dust for blast burning, but the long haul is objectionable. As peat abounds, producer gas may ultimately be used.

DRAINAGE.

'Coming now to the matter with which this report is mainly concerned: the drainage of the low area which has been already outlined, I beg to submit the following facts: They have in the main appeared in my report for 1910. As I have pointed

out in that report, I levelled Demi Charge rapids at the discharge of the Saskatchewan river into Cross lake, and found in them 6·75 feet fall. Above those rapids the current is strong for about a mile and the fall here is, I feel confident, enough to make the total fall down to Cross lake 10 feet. Above this swift current there is a lake-like shallow expanse for a mile or more, in which there would not be more than six inches of a fall. At the head of this we again enter current, which gradually increases into a rapid. In this rapid the fall is not less than three feet, and from the head of this up to Cedar lake the current is pretty strong and would indicate a fall of about two feet, totalling fifteen feet fall between Cedar and Cross lakes. It was my intention to go to the vicinity last fall, level between those two bodies of water and determine the exact drop, but the hindrances I have set forth in my itinerary prevented it. However, I have had a good deal of experience on rivers and not a little in determining the fall of them, and I feel confident my estimate in this instance is not very far from the truth.

Just across Cross lake there is a short sharp rapid in which there is a fall of five feet: this is over a limestone ridge, as is Demi Charge rapids.

Dr. Otto J. Klotz in his report of 1884 gives the distance between Cedar lake and Cross lake, 6·7 miles. While compiling my map to accompany this report I had before me the plan of Dr. Klotz's survey plotted on a scale of one-half mile to an inch. The distance between the lakes measured off this plan is somewhat under 6 miles. The doctor evidently derived his distances by adding his traverse courses, which are not always in the direction of the axis of the stream bed. The plot also shows that the distance between the lakes in a straight line is considerably less than that of the axis of the river. How much less it is impossible to precisely state till a proper survey of the shore of the lakes is made. Then, too, the survey of the river by Klotz is only an approximate one and some difference may be found there.

For an approximate estimate of the cost of deepening the river bed, if this course is found the best, I will assume the distance by it as 5·8 miles. The river bed midway in Demi Charge rapids is 1,100 feet wide, assume as sufficient for discharge purposes a width of 1,000 and a depth of 10 feet; or cross sectional area of 10,000 feet; now at the head of Demi Charge, while I cannot give the depth of water, I know that for about one-third the width from the north shore it is shallow, when I was there in 1910 averaging for this distance not more than one and a half feet. The southerly two-thirds would average three and a half or four; I will assume the shallower depths; this gives a mean depth for the whole width of 1,100 feet of 2·84 feet. The fall in the rapid is 6·74 feet and, assuming a depth of 10 feet at Cross lake we have 16·74 feet from the surface of the water at the head of the rapid to bottom level at Cross lake, but as we have 2·84 feet of water at the head of the rapid the depths of rock to be removed there would be only 13·90; assuming this tapers to nothing at Cross lake, we have a mean depth of 6·95 feet for a distance of about 1,600 feet to remove. This with 1,000 feet of width gives in round numbers 412,000 cubic yards. Much of this will no doubt prove loose rock at the lower end of the rapid, and out into Cross lake, which can be handled with a dredge. What proportion this loose stuff would bear to the whole of it is, of course, until examination, impossible to say, but I think it may be safely assumed at not less than 50,000 or 60,000 cubic yards. The cost of carrying away after removal will be small, for there is abundance of dumping ground in the south end of Cross lake just at hand. Filling the lake will involve no damage to any person or interest. Assuming that the 50,000 yards of loose rock can be removed at 25 cents per yard, and the 362,000 yards of rock for $1.25, we have $12,500 and $452,500, respectively, making a total of $465,000 for the whole. Since there is 8.26 feet fall between the head of Demi Charge and Cedar lake and a depth of 16·74 feet below the water surface at the head of Demi Charge rapids, we would have 25·00 feet depth below the water surface at Cedar lake. The mean of the two terminal depths is 20·87 feet. Over this area I do not think the depth of water will average less than 6 feet, leaving a mean depth of gravel and rock of 14·87 feet to be removed, for a

distance of about 29,000 feet. This gives us with 1,000 feet width 15,971,481 cubic yards. If it is all gravel it can be raised with a good bucket dredge of say not less than 5,000 cubic yards per day of twenty-four hours, and carried away to the dumping ground, which is just as convenient in Cedar lake, as at the lower end in Cross lake at a cost not exceeding 10 cents per yard.

This would with the above assumed yardage amount to $1,597,148, making with the estimated cost of the rock work at Demi Charge, a total of $2,062,148. This is more than the estimate I submitted for consideration soon after returning from the field, but that one was based on a discharge channel only 800 feet wide and 8 feet deep, or 64 per cent of the capacity of this one. In the preliminary one, however, one-third of the removal above Demi Charge rapids was estimated at rock prices.

As to the question of a channel to meet all requirements of discharge, more knowledge of the average volume will have to be acquired before that question can be decided.

My determination of the discharge at Grand Rapids, which for all practical purposes may be considered the same as at Demi Charge, in July, 1910, was 35,324 cubic feet per second. As I have shown in my report for that year, this was unusually low for that time of the year, in fact it was considered by the old-timers at the rapids, full level, and not a great deal more than low spring level. While I was at The Pas last August, Mr. Cross, for the Department of Public Works, made an approximate measurement of the discharge of the Saskatchewan at that point, and found it about 50,000 cubic feet per second. There would not be much difference between the discharge there and that at Grand Rapids. This is 41 per cent more than I found it a year before, and while this is probably in excess of the average for that time of the year, it must be borne in mind that for short periods the discharge is a great deal more, probably 100,000 cubic feet or more, and if provision is not made for this there would be some flooding of low parts in the lands reclaimed.

It may prove that a channel could be more easily cut through the strip of land between the two lakes than deepening the river bed. The distance by the river bed, as has been stated, is about 6 miles, and it may be found that a channel cut in the shortest possible distance between the lakes would not be more than three. I am positive it would not be much, if any, over four. As I have intimated, this is a matter of survey of the lake shores and need not involve more than ten or twelve days' work. It seems to me that a place could be found for such a channel that would avoid rock cutting altogether. It must be borne in mind that in the river bed a great deal of gravel has already been removed, and it is a question for detailed examination as to whether the long channel of the river bed or the short cut across the land would prove the most economical of construction.

To do this, first a survey of the lake shores and a connection between them would have to be made. This done, a series of levels would have to be run to find the lowest line for our proposed canal. After this was established a series of drill holes would have to be put down in both river bed and overland site to determine the depths of the gravel in both plans. In those on the river the depths of the water referred to some standard mark on shore would have to be made at each drill hole. This completed, it will be easy to map the work and show pretty closely how much gravel has to be removed and how much, if any, rock.

With the current wages in the district, the cost of fuel and other necessaries, a good approximation to the cost of the work required for reclamation can be made. In addition to this, readings of the height of water at or near my cross section line of 1910 could be made from time to time and the velocities of surface current read for comparison with those I had in 1910 from which could be deduced the discharge, by comparison with my 1910 measurements.

The drill for use on those tests would have to be self propelling, or traction as it is termed, to work on the land, as there are no horses in the vicinity to draw it. For the river work it would have to be mounted on a suitable scow, the lumber for which

can be bought and the building done at The Pas. For this work a No. 3 Traction Keystone drill would suit admirably. This machine would cost fully equipped for the work, $1,427.68 f.o.b. New York. This figure includes every extra and duplicate that can be considered necessary in such an out of the way place. Provision is made against every breakage or accident likely to occur under ordinary working conditions. The weight of the machine is, without tools, about 12,000 pounds, but crated for shipment it is about 19,000. The tools and piping would go about 3,000 pounds more. The piping necessary would not exceed 75 feet.

A crew of 8 men in addition to the chief will be required to handle one of these drills.

In my report of last year I refer to the existence of four shoals in the bed of the Saskatchewan river between The Pas and Cedar lake, which might have to be dredged out to permit the country above The Pas to get the full benefit of the lowering of Cedar lake. At that time I did not know anything personally of the Moose lake or Summerberry branch of the river. Last fall I came up this channel and did not observe on it any place that would not likely be scoured out by the lowering of the water in Cedar lake. This would be a longer route than by the Southern or Cedar lake channel by a few miles if the Moose lake channel were followed, but the cut-off known as 'Head river' would so reduce this that there would be very little difference in the length of the channels. As illustrating the eroding in the sedimentary deposits of this area, I was told that more than forty years ago the Summerberry river broke away from the original channel that flowed past Chemihawin into Cedar lake and took a more direct route, and has since scoured a bed 40 feet deep in places. Just how lowering Cedar lake 15 feet or more would affect the Saskatchewan river above it, and how far, can only be inferred at present. That the rate of fall in the river between the head of Sepanok channel and Cedar lake is small is self-evident from the rate of the current. I did not have an opportunity to level any part of it with the exception of a short distance about 24 miles below The Pas, and found the fall to be about 0.3 feet per mile. This is small, and probably the average is more, but the current, with the exception of a very few places, is slack. At The Pas it is rather strong for a short distance, but even there it cannot be called rapid. In my report for 1910, I discuss the elevation of Cedar lake, and from the best available data I find it 822 feet above sea. This is based on the elevation assigned Lake Winnipeg on our maps—710 feet. Since writing that report I have learned that the elevation of Lake Winnipeg, as determined by precise levelling done for the Department of Public Works from Stephen, Minnesota, U.S.A., where the United States Coast and Geodetic Survey had fixed with accuracy the elevation, to Winnipeg beach on that lake, was at 11 a.m., September 12, 1911, 715.06 feet. The zero mark of the board gauge on south side of the Government wharf at this place, however, was 712.16, or 2.90 feet lower. It appears this zero mark represents as far as known extreme low water mark on the lake. What the elevation of the mean height of the water may be is not stated, and it is probable it is not yet established.

However, the elevation 715.06 being taken about the middle of September, when under ordinary conditions the water would be somewhat below summer level, may be assumed as approximately pretty close to mean level. Taking it as such, I infer from the levels and observations I made between lakes Winnipeg and Cedar, that the elevation of the latter is 827 feet.

The elevation of The Pas established by levels taken by the Department of Public Works along the Saskatchewan river from Edmonton down is 847.5 feet, subject, however, to a correction of several feet, which may make it over 850. For purposes of comparison we will take the first figure, and we find a fall of about 20 feet in nearly 70 miles of stream, or about 0.3 feet per mile, which accords with what I found it in my very limited test.

The fall between the head of Sepanok channel and The Pas from the same authority is about 44 feet in a distance of 127 miles by the old river bed. This averages 0.35 feet fall per mile, very little more than that shown between The Pas and Cedar lake.

I did not go over that part of the river's course between the cut-off, four miles below the head of Sepanok channel and the mouth of Touring river, but having gone up Carrot river, and from it through Sepanok channel to the Saskatchewan, I can testify that the current is not strong in the Saskatchewan, for in the Carrot it is not much more than perceptible for more than half the distance to the channel, and the rest while showing a current does not do so in any marked degree. At no point was any difficulty found in paddling against it.

In Sepanok channel, for about 20 miles out of the probable 70 of its length, from the mouth up the current is not much more than perceptible. Near the mouth it was found to be not more than one-fourth of a mile per hour. In its mid-reaches it is alternately deep and shallow with correspondingly slow and fast current, but at no place was it more than about two miles per hour. The upper eight or ten miles averaged stronger current, with many shallows, some of them notwithstanding the steady rise in the water for several days, not more than deep enough for us to get through. At the head of the channel the water was so shallow in places it is evident that only at times of high water does any come through from the Saskatchewan at all. It was apparent that, if there were much discharge through this channel, it would soon cut out a much more extensive bed, for its average width is only about 70 yards. The nature of the soil would readily yield to a current and soon afford a good channel.

If the action of the river in the past, in making new and deep channels for itself within the bounds of the drowned area be any criterion to judge of the future, we may with confidence assume that in the event of lowering the level of Cedar lake, the river will in a very short time deepen its bed sufficiently to drain all the area sought to be reclaimed. No doubt there will be spots through which it will take some time to do this, spots also where it may be necessary to give the current some assistance, but those I believe will be found few in number and easy of removal. One such obstacle may be found just at The Pas, where for a distance of about a mile the bottom of the river bed is gravelly. However, here the depth may prove sufficient to allow drainage enough above it for the purpose sought.

As to diking or levelling the banks to prevent overflow, as was done on the lower Mississippi, if it is necessary at all, it will likely be so at only a few places and for short distances. This, however, is a matter that can only be positively learned after drainage has been accomplished and the river bed has reached its final level under the changed condition. Pending this decision there is plenty of surface so free from danger of flooding that the objection will have little practical bearing on the result of the work.

It has been urged against the practicability of this reclamation scheme, that a tortuous river running through an alluvial country cannot without great difficulty be straightened, that the tendency of the river is to preserve its meanderings, and retain in this way the old levels by increased length of channel. The case of the Mississippi river has been quoted in proof of this contention, and the argument advanced that efforts to lower that river bed by straightening it in the lower reaches of its crooked bed have been unavailing, as it will in spite of all efforts cut itself a meandering channel again. This may be so to a limited extent, but that the gain in shortening exceeds that in lengthening is true seems beyond question. In an article on the Mississippi river in the 11th Edition of the Encyclopedia Britannica, 1910-1911, reference is made to the formation of 'cut-offs' by which the river cuts across the narrow neck of a bend, thus forming a new and shorter channel. The ends of the old channel round the bend are soon filled up and a crescent lake, 'which are so marked a feature on the maps,' is formed. Nothing is said of the formation of new channels to compensate for this loss of length.

In the bibliography of this article among the authorities quoted is 'Mark Twain,' and so I venture to introduce him here. His fame rests on his humorous works, but he could be serious, and as he was a pilot on the river for several years, he had experi-

ence and could acquire historical knowledge. In his old 'Times on the Mississippi' he devotes a good deal of one chapter to the shortening of the length of the river, and tells us that in less than two hundred years the river has shortened its course between the mouth of the Ohio and the city of New Orleans more than two hundred miles. He says nothing of any cutting of new meandering channels to keep up the original length.

In the case of the Danube river in Europe, low alluvial flats bordered its course in Hungary for 337 miles. In those flats its course was tortuous, and continually changing. It has been regularized and straightened, shortening it 75 miles, 22 per cent of the original length. However, these cases are hardly parallel with the proposed scheme; in the case of the Mississippi, the channel is narrow compared with its discharge, which at the mouth of the Ohio rises as high as 1,400,000 cubic feet per second, while at New Orleans, about a thousand miles down stream, it never rises above 1,300,000. The average fall per mile for the upper portion of this distance is about 8 inches per mile, while for the lower 346 miles, from the mouth of Red river to the gulf the total fall in low water is only 5½ feet, or one-fifth of an inch per mile. Flood level brings this up to about two inches per mile. Such a large volume of water in such a comparatively narrow channel with so little fall might be expected to be unruly. Could the Gulf of Mexico be lowered and the fall increased, the problem of controlling it would be simplified. In the case of the Danube through the alluvial flats in Hungary, where the average discharge is 235,136 cubic feet per second with an average width of channel of 470 yards, the conditions are not so difficult, but here too all the efforts to improve conditions have to be confined to the river channel; no lowering of the receiving basin can be made. In the Saskatchewan the conditions are reversed; the receiving basin can be lowered sufficiently, I think, to draw off the water and with some attention to the river bed at critical points, accomplish all that is necessary to reclaim the lands outlined on my map. The average width of the channel is little less than that of the regularized Danube, while the average discharge is less than one-sixth, and the extreme maximum hardly ever exceeding one-half of the average of the Danube. I think, therefore, it is evident the problem in the case of the Saskatchewan is fundamentally different from that of the Mississippi or Danube; in the latter two cases it is to confine the waters to the smallest possible discharge bed, which has been done at great cost. In the former case it is to let the water off, which can, I feel confident, be done at comparatively little cost. The Saskatchewan bed from above the low lands down to Cedar lake has a fairly straight course. I do not mean that the river runs in a straight line between those points, but that, while it has large bends and turns, it is comparatively free from the short, sharp turns which constitute a tortuous or meandering channel. In its existence it has had provocation enough to change its bed many times, for it has very often overflowed its banks and submerged a great deal of the low lands adjoining it, and at times all of it. In this way it might have established new channels, but in the historical period it has seldom done so. This is no doubt due to the comparatively small discharge compared with the bed of the river, and the uniform flatness of the low land, making it difficult to adopt any particular line of change in preference to any other. At the head of the low area one would infer changes of channel through the efforts of the pent-up waters of the narrow channel in the high lands to distribute themselves over the low lands, and such changes have come as has been told, but only as far as we know, two in number.

In the vicinity of Cedar lake there are numerous channels forming the usual delta at the entrance of a stream to a lake or sea. The usual shoaling at the mouths of those has taken place by the deposition of sediment in the slacker current in the lake waters. Naturally the sediment here would be finer and lighter, the heavier parts of it having been dropped on the upper reaches, and we might expect some change of channel through this fine silt by abnormal rise in the water, but so far as we can learn no change has taken place at the entrance to the lake and only a slight one a short distance above it, brought about no doubt by some temporary piling up

of the waters on the low lands and their seeking readier access to Cedar lake, for the several channels into that lake seem to have been much narrower in the not very distant past than they are now. Certainly the width of the channel shown by Klotz on his plan of survey of the river between The Pas and Cedar lake in 1884, twenty-eight years ago, is much less than I observed it in 1910 and 1911. The last change of channel in the Cedar Lake district appears to have been in 1870 or 1871, and the big divergence at the head of the low area, known as the 'Cut Off,' from the Saskatchewan into the Torch was made in 1872. In this change the river broke through its dike-like banks into the lower level behind, and cut across a long point known as 'Mosquito point,' shortening the channel about four miles, but at the same time, or soon after, it burst over the bank at the lower end of the point, cut itself a channel through about four miles of ground into Torch river which it enlarged, and discharged a large portion of its water into Cumberland lake; so much of it, that the new course soon became the steamboat channel. In this change of course it flowed up a part of the bed around Mosquito point, which gives an idea of the flatness of the country.

I have already told of the change from the former Torch river bed into the lower lagoon-like flats north of it.

Since those dates there have been seasons of excessively high water of which I have spoken, yet the only change of channel has been the one last referred to. It appears then only reasonable to infer that if the deepening of the channel between Cedar and Cross lakes is begun at the upper end and so carried on that the change of level in Cedar lake is gradually accomplished, that the Saskatchewan will remain in its present bed, or, in the vicinity of Cedar lake, heals, and gradually erode it, or them, to accommodate the discharge into the lake. It may prove that at some points, as has been already mentioned, hard bottom for short distances will require some attention to enable the water to cut through, but that can only be learned as the work progresses, or by an extensive and costly process of drilling.

If the work is undertaken it might be well to lower the bed of the river from 'Mosquito point' down the old channel in order to induce the accelerated current to scour out the old bed and resume its original course.

It has been objected that the deepening of the channel in the way intimated would interfere with the navigability of the river, but it appears to me that the work could be made to benefit the navigability by watching the tendency of the current at dividing points in the channel, and helping the stronger part to confine all the water in one channel. This would apply particularly to what might be termed the delta above Cedar lake.

This lowering would no doubt uncover a large part of the bottom of Cedar and Moose lakes. In the former it would probably settle the lumber question. Various estimates of the extent and value of this substance have been made. As it is altogether under water at present, all that is found being gathered on the beach after a strong north or northeast wind, this drainage proposition carried into effect would uncover a large portion of the amber bed, if not all. The Indians repair to the beach after a storm, gather all they can, and sell it at the Hudson Bay post for about 10 cents per pound.

While I was at The Pas last summer I met two representatives of an American paint and varnish making firm who had gone down to inspect the deposit with a view to securing an interest in it on behalf of their firm. One was a business man from the company, the other an amber expert. They considered the amount of amber too problematical, and delivery in any definite quantity too uncertain to justify any investment at present.

The waters of Moose lake are discharged into Cedar lake by two channels. The principal one is known as Moose Lake creek. It is about four and a half miles long and discharges into Summerberry river. During times of high water in the river and ordinary level in the lake the river discharges into the lake, and when the Summerberry or Saskatchewan is medium or low the lake discharges into the river. The

other channel of discharge is known locally as Sturgeon river. It leaves Moose lake, about a mile east of the head of Moose Lake creek, and flows southwestward till it almost breaks into Moose Lake creek, about two and a half miles from the lake. The two streams are only one hundred and fifty yards apart here, then the Sturgeon turns southeastward into the northern part of Cedar lake called Clear lake. There is said to be a rapid over a limestone ledge in Sturgeon river, and in very low water there is said to be a slight rapid in Moose Lake creek. It is probable then that in order to give Moose lake all the benefit of the lowering of Cedar lake some work would have to be done here. When I left Moose lake, October 20, there was not much current in Moose Lake creek, and I could not observe any at all in Sturgeon river where I saw it, so the discharge into Moose lake must be small. As it is reported shallow it is probable that lowering it about 15 feet would dry a large part of its area. This would permit the draining into it of other smaller lakes around it.

SOME SUGGESTIONS REGARDING USE OF CARROT RIVER AND THE SEPANOK CHANNEL.

In the event of the reclamation of this area it will be found that the beds of Carrot river and Sepanok channel can at little cost be converted into canals for the conveyance of produce raised along their course to The Pas. The soil along the Carrot above the low lands is of the finest quality, and when the Hudson Bay route is an accomplished fact The Pas will be the market for its produce. It might prove that deepening the head of Sepanok channel to allow a good discharge of water through it from the Saskatchewan would do all that is necessary in the way of deepening the channel sufficiently for high-draught steamers, both in the channel and in the Carrot below it; but this is a problem that only a survey can definitely settle. On the Carrot above the Sepanok, as I infer from accounts furnished me of the bed of the river, locks will have to be built. An extensive jam is reported on the Carrot above Shoal lake. This has been accumulating for an unknown period, until now it is said to be nearly a fourth of a mile in length and in places 15 to 20 feet deep above the ordinary river bed. It is likely that the water has worn a passage underneath the jam and has left it higher than it was at first. The Indian agent and others in the vicinity think it most desirable that it should be removed, as it much increases the cost of freighting supplies from The Pas to points on the river above it. There is no great engineering difficulty in the task and it need not take a half dozen men more than a season to do so. The logs as liberated will be carried down stream and into the Saskatchewan, so no trouble nor expense need be apprehended in the matter of disposing the refuse. In the same connection The Pas river might be made serviceable for forty or fifty miles, but it is so close to the line of the C.N.R. it will not be required so frequently as the Carrot.

METEOROLOGY.

Records of the minimum temperature, and the reading of the thermometer at one o'clock each day, were kept from the 1st of August till the 25th of October, a summary of which I add here. Highest temperature in August, 78 degrees, occurred three times, 2nd, 12th and 19th; lowest reading at one p.m., 52 degrees, on the 20th, mean reading for the month at one p.m., 69·5 degrees. The lowest minimum reading for the month, 33·15 degrees, on the 25th, in the Cumberland lake vicinity. The minimum was below 40 degrees only three times in the month, the 22nd, 25th and 26th. The highest minimum, 51·5 degrees, the 14th, on Carrot river. I may say the temperatures were higher while on this stream and Sepanok channel than anywhere else on the work. The mean minimum for the month was 47·
reading of the barometer for the month, 29·37 inches, the l
mean, 29·20 inches.

The record for September shows the highest temperat
on the 1st, the lowest, 41·0 degrees, on the 27th; mean

p.m., 56·8 degrees. The lowest minimum temperature for the month, 20·0 degrees, on the 27th, at Chemihawin, the next lowest, 25·0 degrees, on the 6th, at The Pas, the highest minimum, 52·0 degrees, on the 16th near The Pas. The number of times below 32·0 degrees, four, the 6th, 23rd, 25th and 27th. The mean minimum temperature for the month, 42·8 degrees. My barometer, an aneroid, was knocked out of order on the 2nd. I fixed it and set it approximately, and afterwards found it about correct. The highest reading for the month was 29·65 inches on the 23rd at Chemihawin, the lowest 28·70 inches near The Pas. The mean for the month, 29·19 inches.

For the first twenty-five days of October the lowest minimum was 19·5 degrees, on the 25th. This was the only time it was below 20 degrees. Nine times it was below 32·0 degrees. The highest minimum was 45·0 degrees, twice, on the 12th and 13th. The mean minimum for the period was 35·0 degrees.

The highest temperature at one p.m. was 67·0 degrees, on the 10th, the lowest 25·0 degrees, on the 24th. The number of days it was 60·0 degrees and above was seven. The mean temperature for one p.m. was 49·5 degrees.

The highest reading of the barometer during the time was 29·52 inches, on the 20th near Moose lake, the lowest 28·75 inches at Moose Lake post; the mean for the term, 29·21 inches.

The temperature of The Pas river water August 1 was 68·0 degrees; on the 5th, at the forks of the river it was 69·2 degrees. Carrot river water on the 10th was 67·0 degrees. Sepanok channel water on the 16th was 65·2 degrees, but the channel is narrow, and shaded by timber from the sun, and the water almost stagnant. The temperature of Cumberland lake and Tearing river on the 30th was 57·5 degrees, of the Saskatchewan river same day, 59·0 degrees. The temperature of the same river September 19 near The Pas, 53·5 degrees; temperature of Cedar lake water October 4, 45·0 degrees; of Saskatchewan river water on the 5th, 46·0 degrees. Temperature of Moose lake water October 18 was 44·0 degrees, of Saskatchewan river on the 20th, 43·0 degrees, on the 21st, 41·8 degrees; in the morning of the 25th 14 miles below The Pas after a heavy local snowfall, 32·5 degrees, at noon at The Pas, 34·0 degrees.

LATITUDE AND LONGITUDE.

I have on my itinerary referred to the determination of the latitude and longitude of several places. For convenience of reference I here note them. The Pas:—My point here was the N.E. angle of lot No. 8, in block No. 11 of the survey made by J. K. McLean, D.L.S., deduced from the subdivision made in that vicinity last summer this point is approximately in latitude 53° 49′ 44″ N., and longitude 101° 15′ 11″ W.

The forks of The Pas river referred to above is in latitude 53° 34′ 21″ N., and longitude 101° 45′ 28″ W.

The junction of Sepanok channel with Carrot river is in longitude referred to The Pas, 102° 26′ 15″ W.; latitude from sun and star meridian altitudes, 53° 33′ 56″.

Cumberland House.—Longitude referred to The Pas, 102° 15′ 24″ W.; latitude from sun and star meridian altitudes, 53° 58′ 31″.

The longitudes given above were all determined from differences of time, shown by three first-class watches, all fully adjusted. As I had no sufficient way of protecting these timekeepers from the increased ranges of temperature in September and October and I could not get any observations at Cedar lake post until my return there in October, I did not trust the watches for that longitude but worked it out by the latitudes and departures from the courses of Klotz's traverse survey. True, the distances by micrometer measurement are not absolute but the result is more likely to be correct than one deduced from the watches.

Cedar Lake post.—Latitude 53° 19′ 34″, from star meridian altitude, longitude, 100° 23′ 21″ W.

The longitude of Moose Lake post was deduced from watch differences of time between there and Cedar lake. The interval between the observation at the places was only three days, during which the temperature was pretty steady, so the result may be considered satisfactory, in any case it is the only one possible.

Latitude 53° 42′ 56″ from star meridian altitudes; longitude, 100° 17′ 13″; nothing could be determined at High Portage, and Klotz's survey having carried along the north shore of the lake, no use could be made of that without a more extended survey of connection than I was prepared to make.

SURVEY BETWEEN LAKES CEDAR AND WINNIPEGOSIS.

'The accompanying plan and profile show my survey and levels over High Portage, but for convenience of reference I tabulate the result at every tenth station; as the stations are 50 paces (yards) apart, this gives intervals of nearly a third of a mile. I have given Cedar lake an elevation of 100 feet for convenience of reference.

Cedar Lake. Station.	Elevation 100·00 feet.
10th	113·53
20th	119·40
30th	130·02
40th	139·28
50th	146·76
60th	151·88
70th	159·03
80th	167·45
90th	177·83
100th	181·01
110th	186·85
120th	185·89
130th	189·47
140th	190·99
143rd—Summit	192·27
146th—Descent to Winnipegosis	192·04
150th	166·15
154th—Water, Lake Winnipegosis	99·31
Ordinary water level in lake	100·92

Cedar lake was high for the date. Old residents thought it from two to four feet above ordinary level; so we may assume three feet. I know it was that much higher than in June, 1910. Winnipegosis was apparently about 1½ feet below ordinary level.'

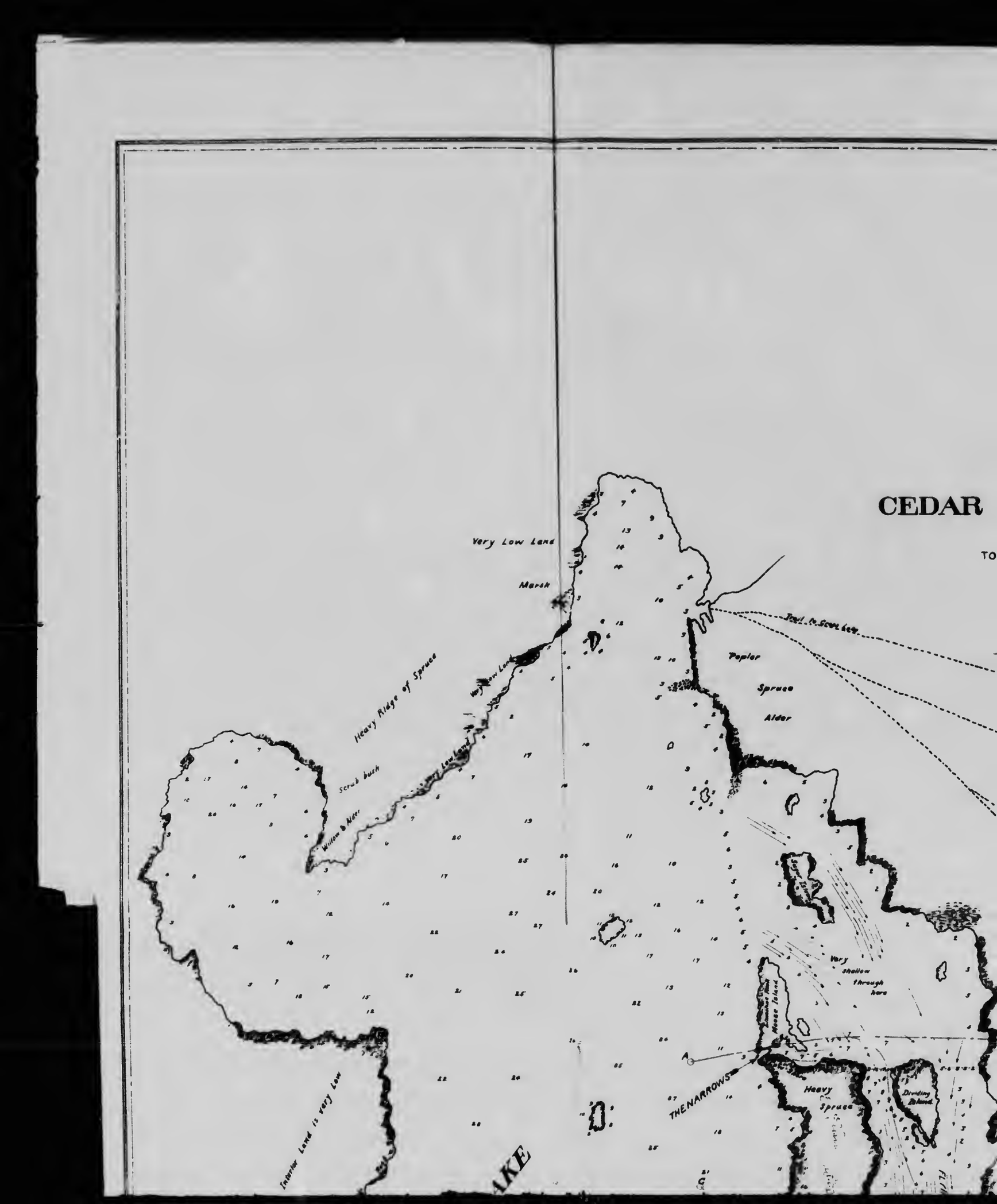

CEDAR
Very Low Land
Marsh
Heavy Ridge of Spruce
Scrub bush
Willow & Alder
Very Low Land
Trail to Scout Lake
Poplar
Spruce
Alder
Very Shallow Through here
Heavy Spruce
THE NARROWS
Interior Land is very Low

PLATE No 36

Department of the Interior, Canada.
HONOURABLE DR ROCHE. MINISTER.
W.W. CORY C.M.G. DEPUTY MINISTER.

Water Power Branch.
J.B. CHALLIES. SUPERINTENDENT.

PLAN

OF PART OF

AR LAKE AND CROSS LAKE

PROVINCE OF MANITOBA

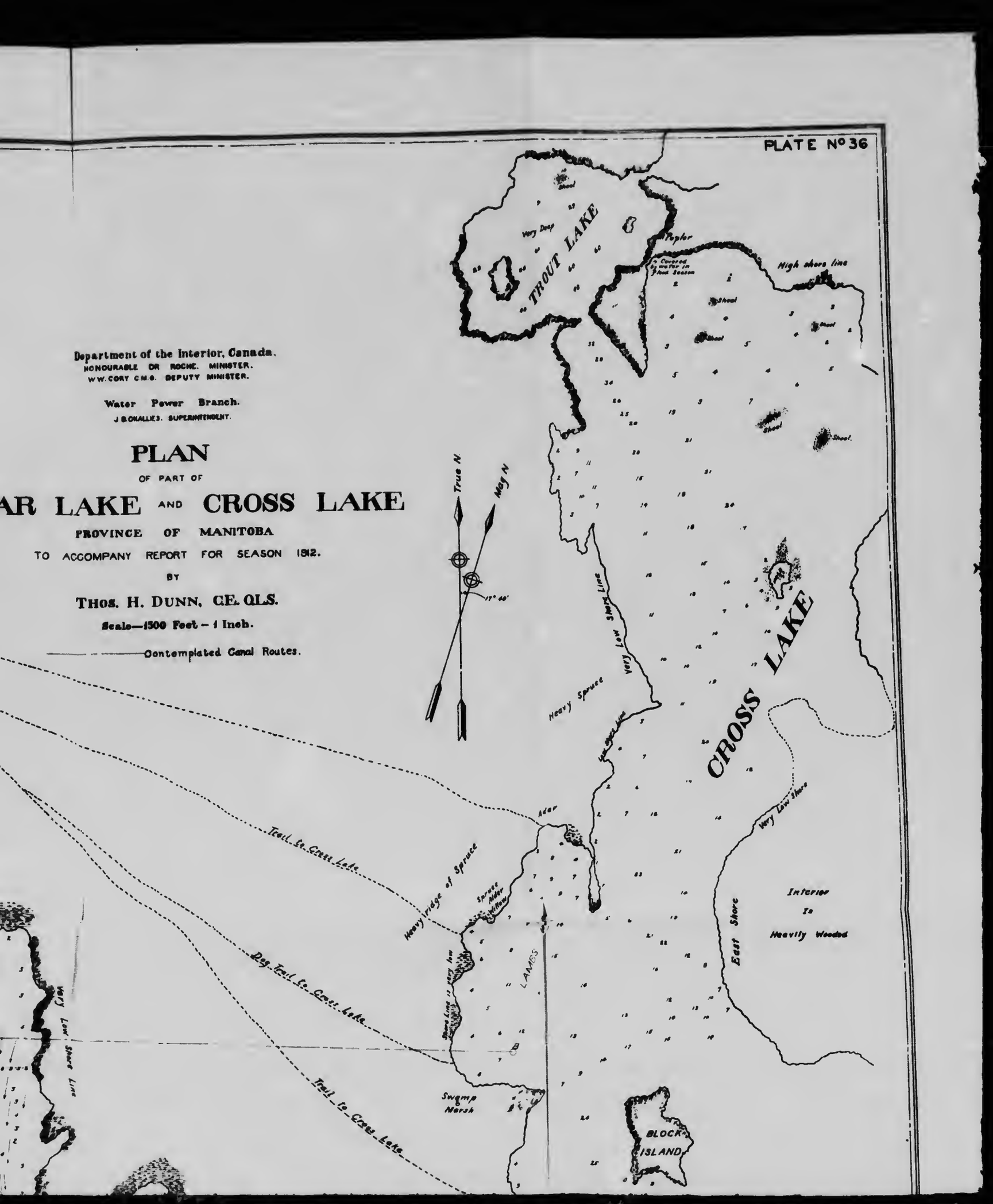
TO ACCOMPANY REPORT FOR SEASON 1912.

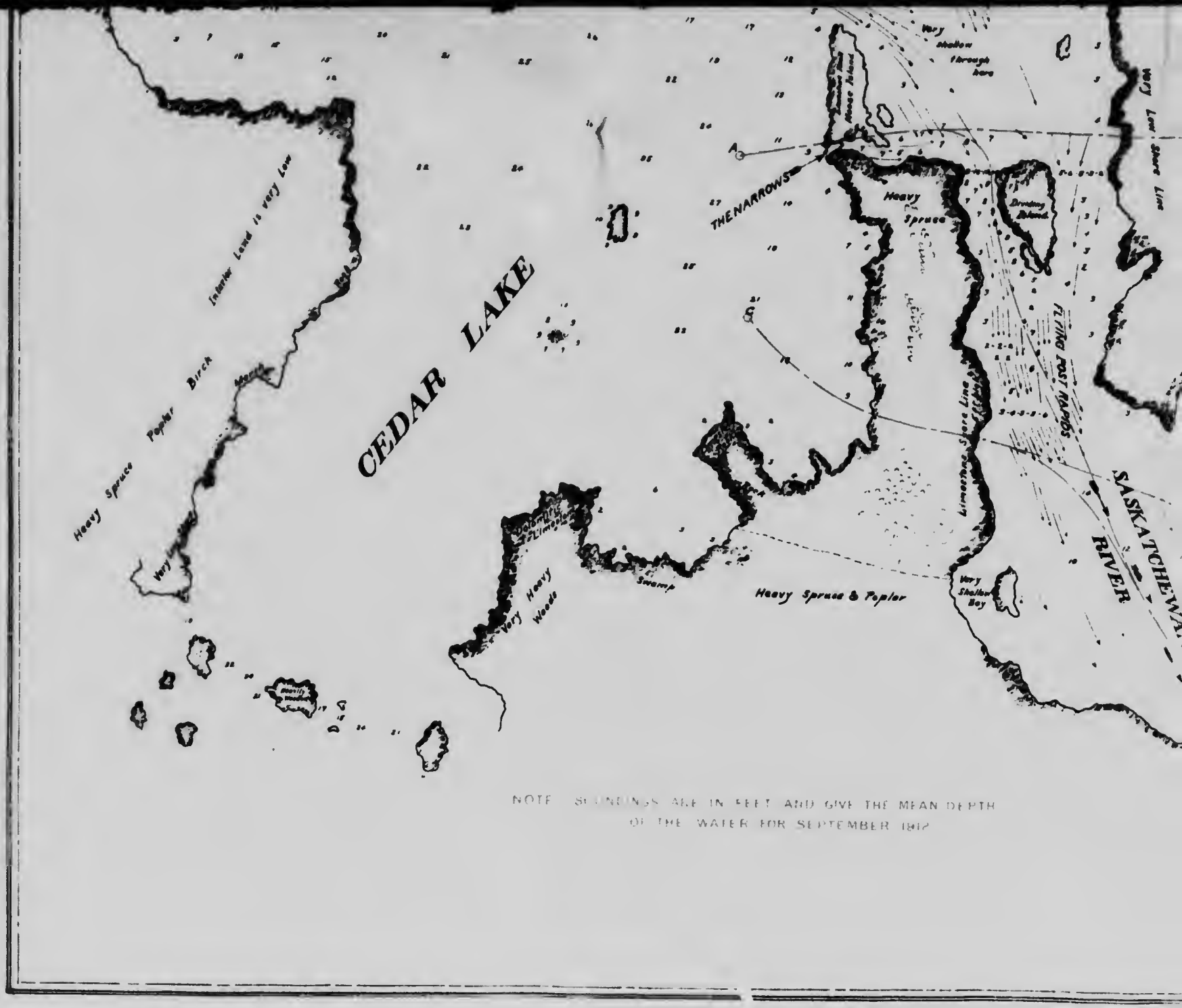
BY

THOS. H. DUNN, C.E. O.L.S.

Scale—1500 Feet – 1 Inch.

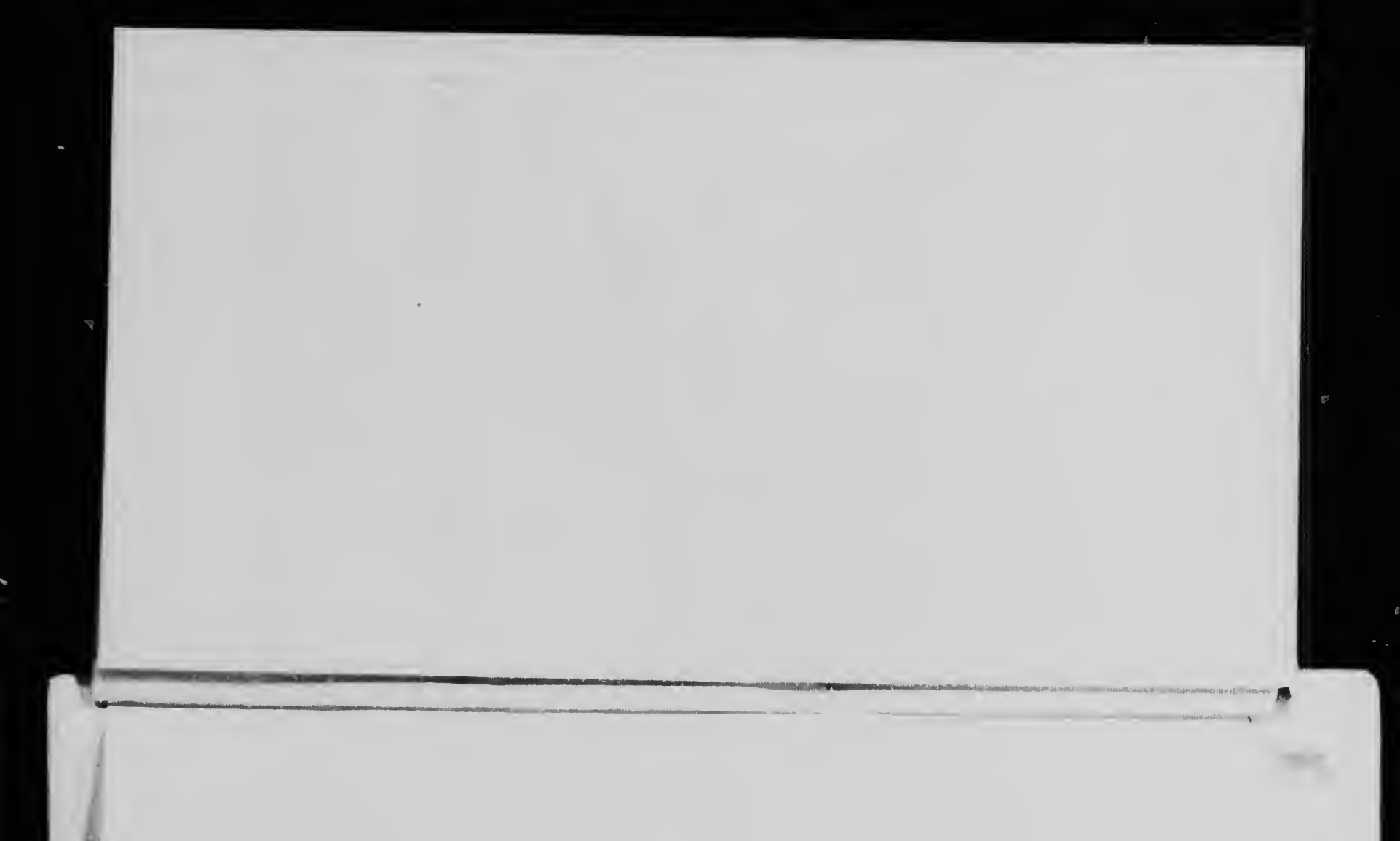
——— Contemplated Canal Routes.





NOTE - SOUNDINGS ARE IN FEET AND GIVE THE MEAN DEPTH OF THE WATER FOR SEPTEMBER 1912


Very Low Shore Line
Dog Trail to Grass Lake
Trail to Grass Lake
LAMBS
Heavily Wooded
East
Swamp Marsh
BLOCK ISLAND
Very Shallow
Swamp Land
Muskeg
CHANNEL ISLAND
Very Shallow
Many Limesto. Ridges
Muskeg
Centre Island
SASKATCHEWAN
Spruce & Poplar
Muskeg
CROSS LAKE
Limestone
ANCHOR POINT
Rock
High
Heavy Woods
DEMI-CHARGE RAPIDS
Spruce Island
O.W.N.C.



Department of the Inte
Water Power

MAP

OF PART

PROVINCE OF M

SHEWING AREA FLOODED BY LOWER

TO ILLUSTRATE REPORT OF THOS. H.

PASQUIA RECLAMAT

SCALE

6 MILES TO ONE

NOTE – THE HEAVY DOTTED LINE INDICA
BOUNDARY OF THE WET

Interior Canada
r Branch.

PLATE No 37

P

T OF

MANITOBA

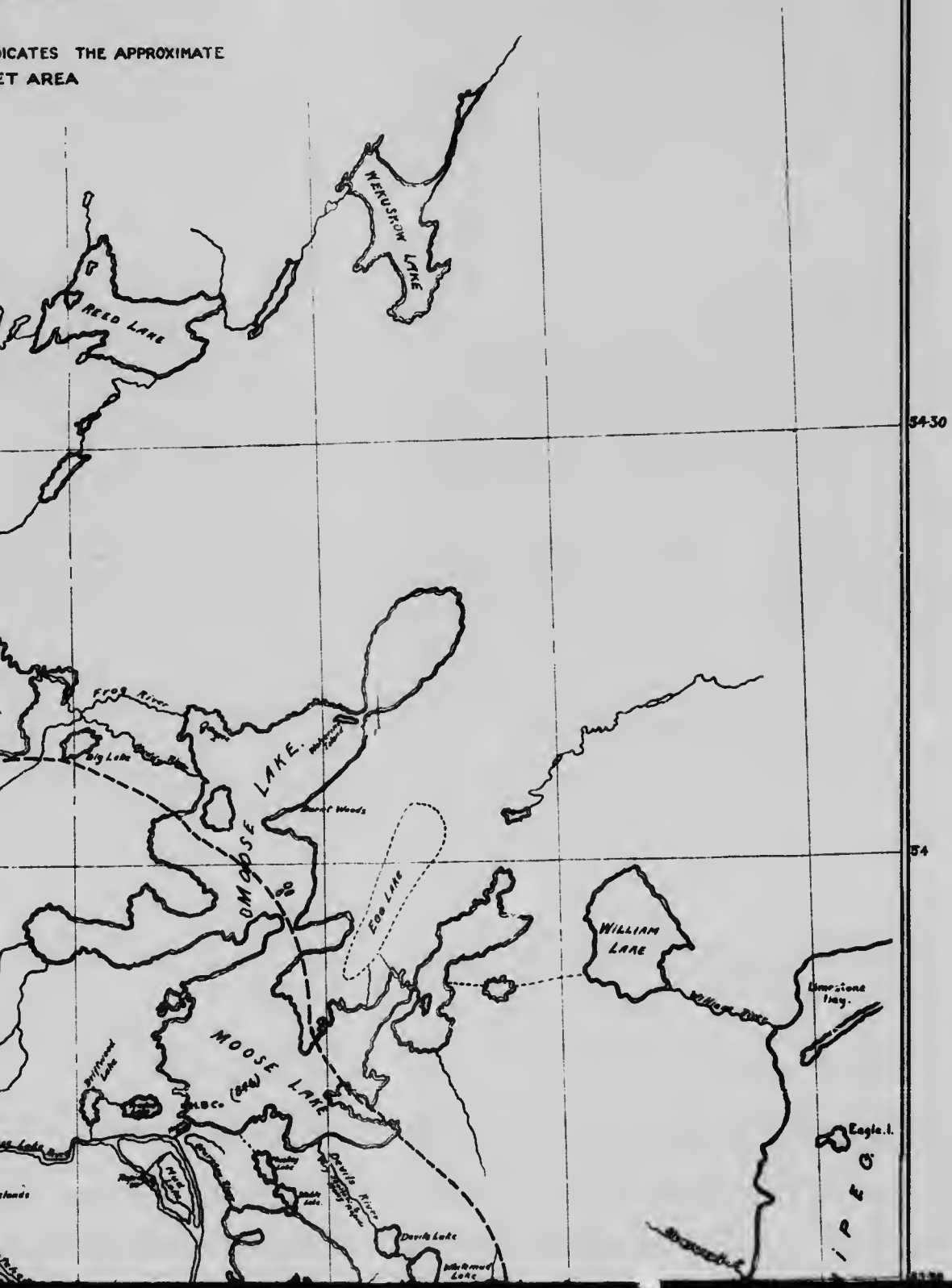
WER SASKATCHEWAN RIVER

H. DUNN. FOR SEASON 1912.

ATION PROJECT.

One Inch.

ICATES THE APPROXIMATE
ET AREA




Carrot River
PROVINCE OF SASKATCHEWAN
River
Pasquia Mountains
Canadian Northern Railway
Pasquia River
PROVINCE OF MANITOBA
Overflowing River
Red Deer River
Red Deer Lake
Dawson Bay
Canadian Northern Railway
Second Meridian
Swan Lake
53 30
53
52 30
102
101 30
101

MOOSE LAKE
Eagle I.
Davis Lake
CLEAR LAKE
Old Channel
The Crossing
CEDAR LAKE
(838)
CROSS LAKE
(715)
LAKE WINNIPEG
LAKE WINNIPEGOSIS
(838)
Grand I.
Bay
SWAN LAKE
BIRCH ISLAND
53·30
53
52·30
100·30
100
99·30

CLASSIFIED LISTS OF REPORTS
OF THE
DOMINION WATER POWER BRANCH

Tha Reports published by tha Dominion Water Powar Branch with tha axception of tha Annual Reports, hava been called Water Resources Papers, and hava been numbered 1, 2, &c.

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Annual Reports previous to 1913 are included with tha Annual Report of the Department of the Interior, and can be secured from tha Secretary of tha Department.
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