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# The Canadian Engineer

*A weekly paper for Canadian civil engineers and contractors*

## CULVERTS—THEIR LOCATION AND CONSTRUCTION

SOME PRACTICAL SUGGESTIONS ON THE DESIGN, CONSTRUCTION AND PROPER LOCATION OF VARIOUS TYPES OF CULVERTS.

By CHAS. D. NORTON.

To determine the proper size opening required to take care of the maximum amount of water that may be expected, is sometimes a difficult matter. There are various formulæ that take into consideration the drainage area, the slope of the ground, and the permeability of the soil; but on railway and trunk road construction, the engineer is generally a stranger to the district, unacquainted with local conditions; there is seldom a map of the surrounding country of a scale large enough to be of any use and, above all, he is always pressed for time.

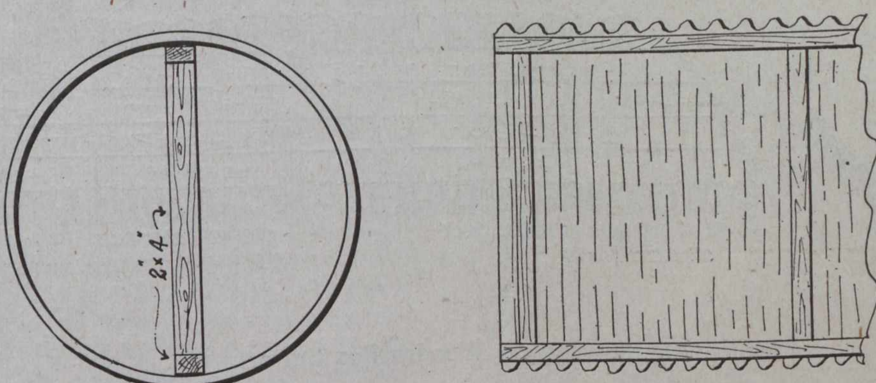



**Fig. 1.—Showing Method of Bracing Large Sizes of Corrugated Iron Culvert.**

In a settled country, the highway bridges, both up and down stream are the best guide, and local records will show whether any previous bridges have been washed away. In cases where the road crosses the valley on a low fill, there is always the likelihood that the stream may flow over the embankment in times of flood. Such a happening, while not very serious in the case of a highway, would be fatal to a railway. It should always be remembered that local construction is often built with a narrow margin of safety; in fact, many structures seem to defy all natural laws, and to hold up by special act of providence.

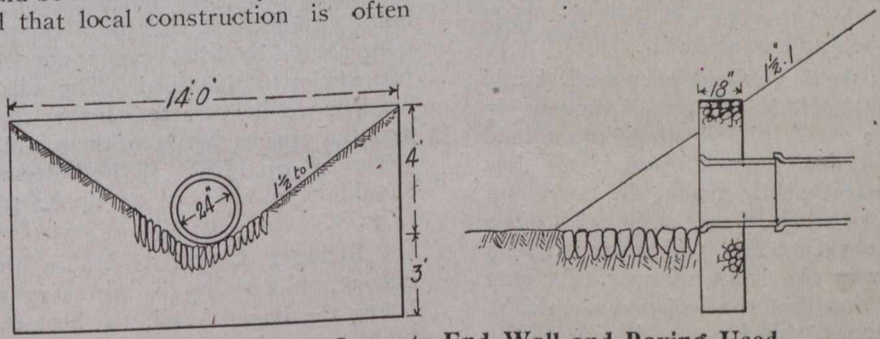



**Fig. 2.—Type of Concrete End Wall and Paving Used with Culvert Pipe.**

The high-water mark should always be looked for, and in the bush that is about the only information that can be found, but there it is much better defined than elsewhere. A rough estimate of the area of the cross-section of the stream in flood, together with the velocity of the water, and the shape of the soil in the banks, will usually give sufficient information to determine the size of opening required.

If possible, the elevation of high water in the spring and after every flood should be taken; the severest floods often occurring in the late summer, and not at the "break-up". A good way to get the high-water level during freshets, is to nail up a board under cover, and on it mark a vertical line with indelible pencil; this line will be blurred as far as the water reaches. At high water, the direction of the current should also be noticed, as the course may then be very different from what it was at low water, and indicate the necessity of rip-rap.

In some districts, provision must be made for the accumulation of ice in the invert of the culvert, as in many cases this will reduce the effective size of the opening at least 50 per cent., just at the time when the full opening is most needed. This accumulation of ice occurs most frequently where the winters are not very severe, and where there are many changes in temperature above and below freezing point. It is also worse in open country than in the bush.

All opportunities of stream diversions should be looked for, and the cost compared with that of an extra culvert. In a settled country they need special consideration, as it is usually unlawful to divert surface water from one piece of property to another, and even where the stream will flow over the same parcel of land, it is best to get the written consent of the owner.

**Type of Structure.**—The type of structure will depend to a great extent upon the available funds, local conditions, and the facilities for handling material. For small openings, pipe is the best; cast iron, corrugated iron, vitrified tile, or concrete, but in no case should a smaller size than 18 inches be used, on account of the difficulty of cleaning. For openings larger than 7 or 8 square feet, a built-in structure is the best, either of masonry or concrete; but if the fill is not deeper than 12 or 14 feet, a wooden box could be put in temporarily and replaced with stone or concrete at some later date when more funds are available. When the opening is as large as 50 square feet, with a fill of 5 or 6 feet, a two-bent pile trestle will cost about the same as a reinforced concrete box, and as the size of the opening or the depth increases, the trestle becomes the cheaper. At the same cost, a wooden box will have a larger opening than a pipe but, of course, will have to be replaced or renewed at some later date.

Cast iron pipe is not as much used as formerly. It is more costly than either vitrified tile or concrete, but is less liable to breakage, though the larger sizes must be handled with care on account of their weight. The smaller sizes are useful on side-hills where there is a small continuous flow of spring water, and the ends can be protected in cold weather.

The writer installed some corrugated iron culverts in the neighborhood of Copper Cliff, Ontario, where the fumes from the reduction plant are very bad, and after being in use for a year they appear to be untouched, and there seems to be no reason why they should not remain so.

These pipes are light in weight and easy to handle. They can be laid closer to the surface than any other kind of pipe, without danger of breakage; but under deep fills and in the larger sizes, are liable to deformation. This can be prevented, however, by placing a scantling top and bottom inside the pipe, separated by struts, all of which can be removed when the embankment is fully settled. Fig. 1 shows such an arrangement.

Vitrified tile, when used for culvert purposes, should be of the kind known as "double strength," thoroughly glazed. They need to be carefully bedded; joints should be packed, preferably with oakum and cement. If they are set closer than three feet below grade, the impact of passing trains is liable to break them, and even when used on highway work a very heavy wagon or a steam roller will destroy them in the same manner. It may seem superfluous to mention that the bell end should be placed upstream, but though this is so self-evident, the writer has seen workmen put them in the other way about. In themselves, vitrified tile are indestructible, but great care must be taken in their laying.

In concrete pipe, like all concrete, the personal element is a most important item in their construction, and unfortunately the inspection of the finished article is often left to inexperienced persons. They should be reinforced with suitable steel wire or mesh, not as is sometimes the case, with common iron wire, which is unsatisfactory. The best shaped pipe are those with a flat bottom; they can be better bedded and are more easily handled in a narrow trench.

All pipe must be well bedded, and should be set a few inches below the natural surface of the ground, and on as steep a grade as possible up to about 1 in 10, although cast iron and corrugated pipe, on account of its being in longer and more solid units, can be laid on a much steeper grade with safety. In backfilling, as much care should be given to the tamping of the earth on the sides as on the top. To enable the pipe to resist deformation, the pressure of the earth should be equally distributed all round it. On no account should any stones, lumps of hard-pan, boulders, or frozen earth be placed next the pipe. As a preventative against wash-outs the ends of the pipe are best protected with end walls, and an apron extending at least three feet from the end of the pipe. If the ground is at all soft, the intake end should have an apron three feet deep (Fig. 2), and the pipe had better be laid with a camber of 1 in 300 to allow for settlement of the embankment.

The best material for a wooden box is cedar, but if this cannot be obtained Norway pine, jack pine or even white pine will do, as the last three will be good for 12, 8 and 6 years respectively; while good cedar has been known to last for 20 years before requiring renewal. The timber should be flatted on at least three sides, and be good and sound all through, except in cedar, when a small amount of heart rot up to about two inches in diameter will do no harm. No length less than four feet should be used, and holes should be bored for the drift bolts 1/16 inch smaller than the size of bolt. The drift bolts should be driven every four feet, and extend through two sticks to the third. The sills should be sunk on a level or an inch or two below the bed of the stream, and the spaces between them preferably filled with flat stones set on edge. If the bottom is soft, then the ends should be paved and an apron placed at the intake. (Fig. 3.)

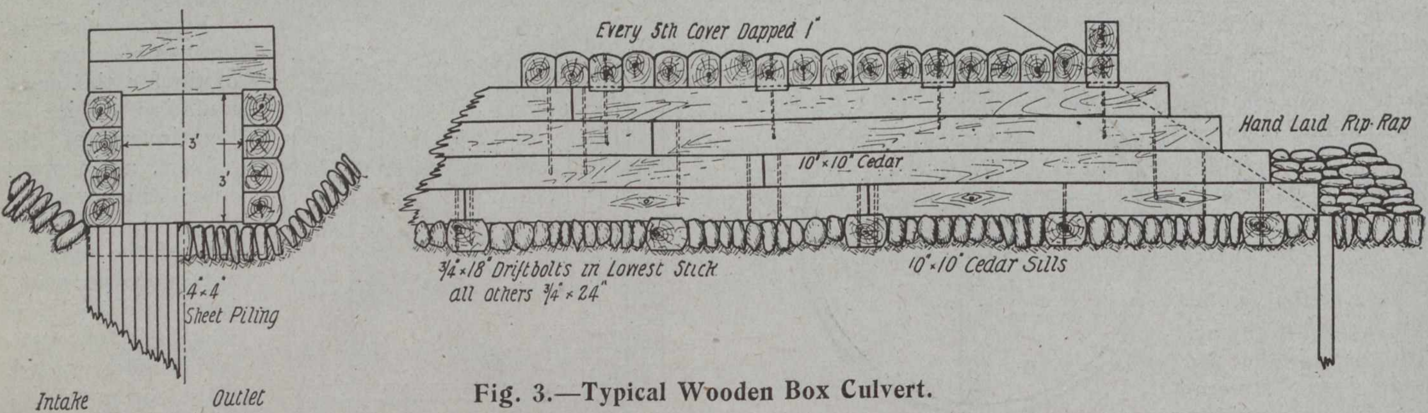



**Fig. 3.—Typical Wooden Box Culvert.**

**Stringer Culverts.**—If, in the case of a railway culvert, an opening is necessary at less than three feet below the base of rail, the best temporary method is to build two cedar walls two to five feet apart in the clear, and place under each rail a stringer either of wood or of three old rails bolted together, the opening being covered with timbers to carry over a car or velocipede. (Fig. 4.) For a permanent culvert so close to rail level, two dry stone walls can be built and covered with old rails. Fig. 5 shows a type of wooden culvert suitable for highways.

**Dry Masonry.**—Where stone is plentiful, and slabs large enough for covers can be obtained, this type of construction is cheaper than concrete, and can be built with ordinary blasting tools and a stone hammer.

They need a very good foundation, and care must be taken that the opening is built to the net measurement, and not to the gross, the net measurement being that of a box, say, ten feet long, that would fit in between the walls. The safe grade for a masonry culvert built on ledge rock is supposed to be 1 in 1 or 45, that being the angle of friction between rock and rock, but anyone building a culvert as steep as that would be taking chances, and a slope of 1 in 2 is as steep as it is advisable to build.

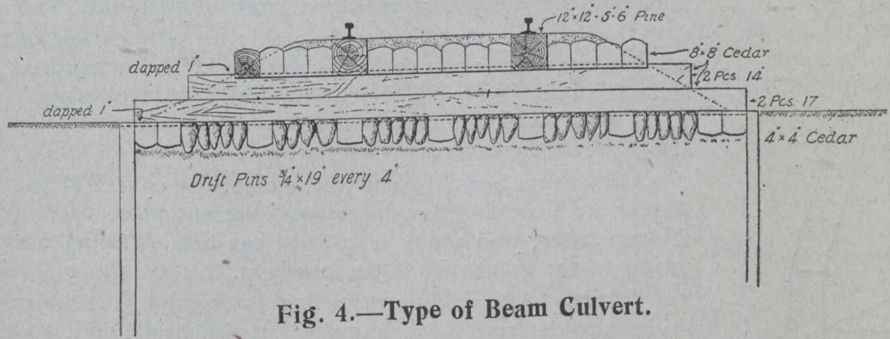



Fig. 4.—Type of Beam Culvert.

**Rubble Masonry.**—If men can be found who can do this class of work this style of culvert can be built of smaller stones than the former at the same cost, and the mortar, by smoothing the inside, lessens the chances of sticks lodging and impeding the flow. If large stones are available, the top can be flat, otherwise a semi-circular arch can be built. The economical limit of size for either a flat-top dry masonry culvert or an arch in rubble masonry is 4 feet by 4 feet.

**Concrete.**—There are three main types of concrete culverts commonly built—the arch, the embedded I-beam and the reinforced—(Figs. 7 and 8), but often the characteristics of two or three of these types may be combined in the one design. A true reinforced culvert is one in which all four sides are reinforced to resist external pressure, and the only type of plain concrete is, of course, the semi-circular arch.

Each of these three types have their ardent advocates, but it yet remains to be proved that one is better than another to any great extent. The plain semi-circular arch, of course, follows a precedent established for centuries, and its only drawback is, that above the springing line, the area of the opening decreases; whereas, with a flat-topped culvert the width of opening is constant to the roof.

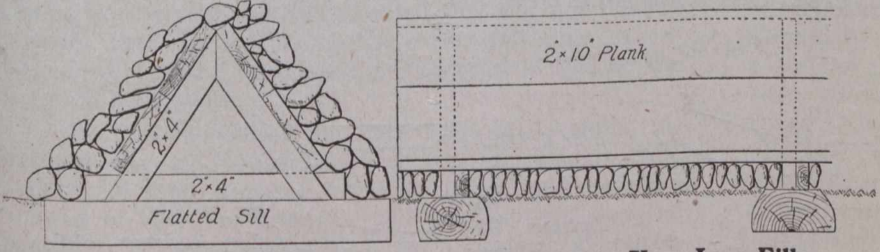



Fig. 5.—Wooden Highway Culvert for Use in Very Low Fills.

Advocates of reinforced concrete sometimes claim that it is impossible to build a plain concrete culvert that will not crack in some direction or other. This idea is based on wrong hypotheses, for if one considers the brick and stone arches that have been built for centuries, it is hard to understand why these should stand up and not concrete. A great many liberties are taken with concrete that would not be thought of with other materials, and when a failure occurs, any reason is given except the true one. A concrete culvert is buried under an embankment, and is, therefore, subject to very slight variations in temperature. The mixture is usually lean and the amount of moisture present is practically constant, so that the only reason for cracking can be poor foundations and poor workmanship. No concrete of any kind, not even for a 3-ft. arch, should be allowed to go in except under strict supervision. On a 150-mile stretch of railway construction in eastern Canada it was not thought necessary to employ an inspector, the result being that all of them developed faults, some failing entirely.

**The Location of the Culvert.**—Although the determination of the correct size and type is in the main the most difficult part of the work, yet there remains the work of locating and constructing, so as to obtain the greatest efficiency. These last two points are often overlooked, and it often happens that of a thousand dollars expended, only three-quarters has served a useful purpose, the remaining $250 being thrown away for want of a little forethought and planning. Too often the culvert is staked out on the ground that is the easiest place to drive stakes, or where the water happens to be running at the time.

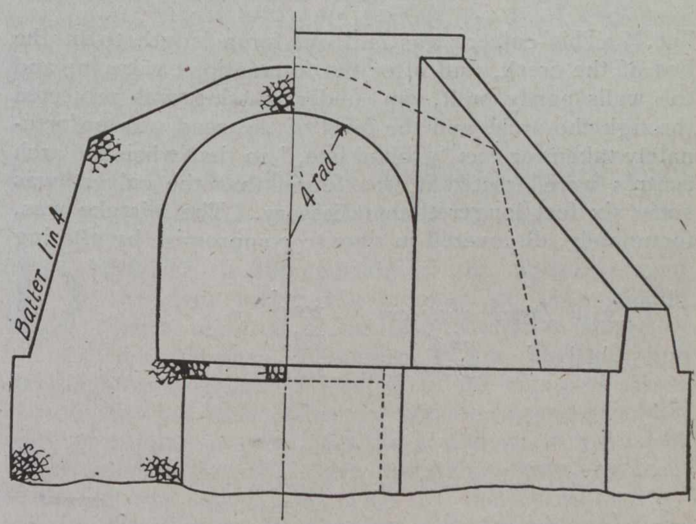



Fig. 7.—Typical Arch Concrete Culvert.

No culvert, not even an 18-inch pipe, should be staked until the immediate neighborhood has been thoroughly examined; and, of course, the larger the structure the more careful should be this examination. In all cases levels should be run on the bed of the stream, and a profile plotted. If the stream is very crooked or the gully wide, a rough plan is also advisable. For the levels, stadia readings are accurate enough, and the best method of taking the topography is with a prismatic compass and a cloth tape or stadia shots. Soundings on the proposed site should be taken in all cases, the number and depth depending upon the size of the culvert. These soundings are shown on the profile as a dotted line.

Upon this profile is platted a cross-section of the embankment, a grade line struck for the invert, and the length determined, both up and down stream, for if there is much fall, the down-stream end will be longer than the other. (Fig. 9.) A formula is convenient for estimating, but no amount of figuring is as satisfactory as measuring the distance on a sheet of cross-section paper, as the following instance will show. On a standard plan of a 20-ft. arch the bottom of the culvert was marked "ground line." This culvert was laid out for a length to fit the bed of the creek, and after the foundations were in, and the walls partly built, an under-crossing was projected through the arch, and the level of the road was unfortunately taken for the "ground line," so that when the arch centres were erected it was found that the culvert was some six feet longer than necessary. The mistake was, fortunately, discovered in time to compromise by altering the shape of the wing-walls. If a sketch plan had been made similar to the one shown in Fig. 9 this mistake could not have occurred.

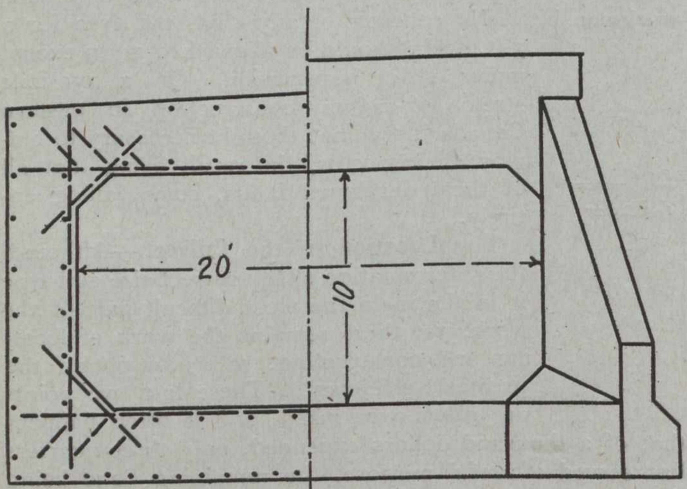



**Fig. 8.—Typical Reinforced Concrete Culvert.**

The first consideration in locating a culvert is to place it at right angles to the centre-line, but care must be taken that the water flowing in will have a straight path, and if the topography is very limiting, it is best to swing the line of the culvert, the extra cost being more than paid by the increased safety from a wash-out.

Due regard should also be paid to a location on which a contractor can economically work, and a hundred feet of intake ditch will often change "wet excavation" into "dry," with a corresponding saving in cost. It may also lighten the contractor's worries.

On stream beds subject to freshets, the course of the water in a flood is often in a very different place to that at low water, and many a culvert has been washed out owing to the want of a little foresight.

**Grade.**—After the centre line is located the next thing is to determine the floor level at the intake end, and if the stream-bed is of a hard, non-erosive soil, this point can be kept as high as the natural bed, but if the soil is soft or covered with muck, then the floor level had better be sunk as low as possible. The profiles (see Fig. 9) will show how far this can go, and if the soil is still bad, then the intake end must be paved, and particular attention paid to the apron.

From the level of the invert at the intake end, a grade can then be struck that will give the culvert as much fall as possible, due regard being paid to the off-take ditch, which, however, need not have as steep a grade as the culvert. It is a great mistake to make the outlet end higher than the ground, for if there is the least

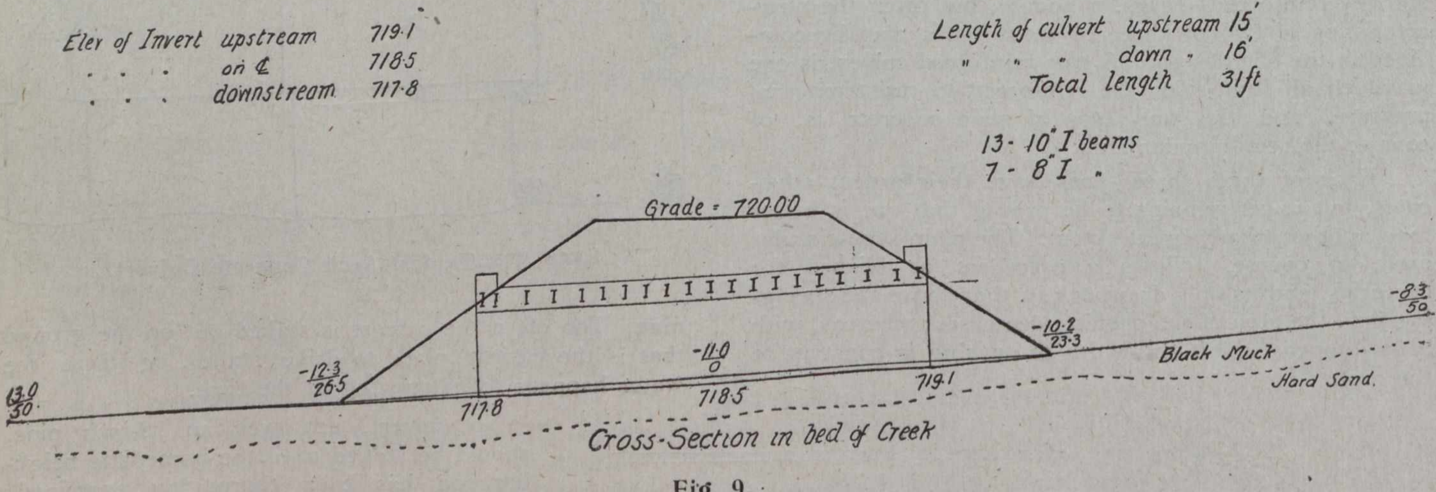
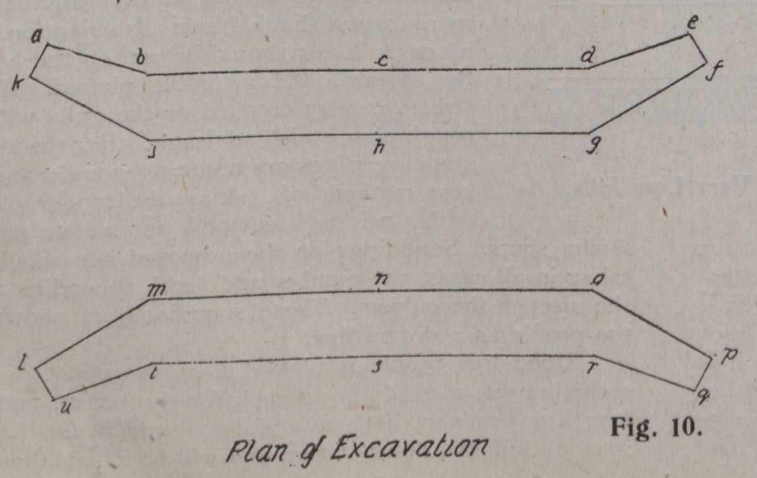



**Fig. 9.**



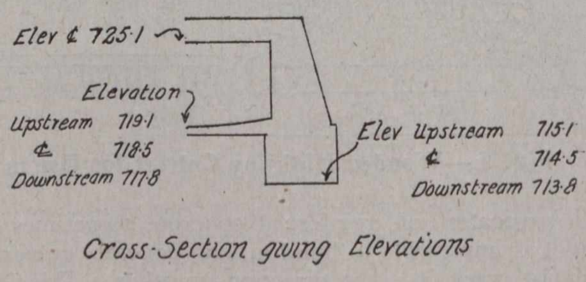




**Fig. 10.**

**Note: The Two Cross-Sections and the Plan would Each Occupy a Page in the Note Book.**

possible chance of a water-fall being formed, any soil except rock will be subject to erosion, with the attendant danger of undermining.

The steeper the fall, the greater is the efficiency of the culvert. The velocity of the water varies as the square root of the change in slope, so that in changing the grade from a two-tenths to an eight-tenths per cent., the capacity of the opening is theoretically doubled, provided, of course, that the water can get away when it reaches the end.

If the outlet ditch is straight, it need not be either as wide as the culvert or on as steep a grade, the water will enlarge the channel; but if the outlet must be crooked or curved, then eddies must be looked for, and, if necessary, the banks rip-rapped.

The nature of the bed of the stream will, in general, determine the fall, the theoretical maximum being 1½ : 1, but in any case it is not good practice to put either masonry or concrete footings on a slope. Although this is sometimes done, they should always be stepped down, the excess cost being negligible.

**Construction.**—After the centre line and the grade are established, the notes are best entered in a field book kept for the purpose, a cross-section of the road-bed and a cross-section and plan of the culvert being drawn therein, showing the various elevations, and a key to the excavation of the footings (Figs. 9 and 10). On a stormy day in winter a field book is much easier handled than a few yards of blue-print paper, besides which, the chances of errors in the staking-out, and erection are greatly minimized.

Usually all that the contractor requires in the way of stakes is the centre line of the culvert, and the faces of the end-walls. If the culvert is skew with the centre line of the dump, then the end-walls must be staked out parallel to this centre line. The elevation of the top of the footings and the invert is all the levels that are generally necessary.

When the excavation is out, the bottom should be tested with a sounding rod to determine its density, and also to make sure whether the material in sight is not merely a mattress covering some softer material underneath. A knowledge of the local geography is of the greatest use. It the strata lie fairly horizontal, river gullies in the vicinity give a fair idea of the underlying soil, although these must not be absolutely relied upon. If the strata happen to dip, there is a chance that one portion of the footings will rest on a softer soil than the other. If the dip is not very great, a uniform footing can be got by stepping down, but if this will not remedy matters, then the footing on the softer soil must be enlarged so that the resistance to settlement will be the same on both soils.

The best foundation soils are ledge rock, shale, indurated clay, and gravel, in the order named. The stability of sand and clay depend a great deal upon the amount of moisture present, their composition, and the possibility of the latter flowing under pressure. Of course, the same precautions are not necessary as with bridge piers and buildings, as a slight settlement will do no harm, provided that it is fairly even. The weight of a culvert is very small compared with that of the embankment on top, and if the subsoil will not hold up the embankment, then any culvert may be expected to fail also. The final test as to whether piling is necessary is in the pile-driving itself, for if they drive easily, then of course they are needed. A sounding rod in experienced hands will give a good idea of the strength of the sub-soil, but if the culvert is larger than 12 feet it is better to drive a test-pile. In any case, if there appears to be a chance of settling, it is best to build the culvert in sections of ten feet or so, the sections being separated with one or two thicknesses of tar paper, and then, if uneven settlement does occur, each section will settle vertically without impairing the strength of the culvert as a whole.

In Canada, the least depth to be safe from frost is four feet, and if quicksand is encountered, the excavation must be protected with sheet-piling. If, however, the quicksand is not found until the last foot or so, the sheet-piling may be omitted by widening the excavation a foot all round, and then digging out a small portion of the quicksand at a time and replacing it with coarse gravel or broken stone until the whole of the bottom is protected with a mattress.

When the invert is paved, and the soil is good, then all the depth of the foundations under the walls needed is 18 inches, provided that the aprons and wings are sunk to the full depth of 4 feet. (Fig. 10). On a long culvert this will effect a considerable saving.

**Backfilling.**—In backfilling any masonry culvert, only one method of procedure should be allowed, and that is to fill and tamp both sides before any material is dumped on the top, and especially so when a dump is being made by the "en-fill" method, for such a fill acts as a semi-fluid, and exerts a most powerful pressure on anything in its path.

## REPORT OF BOARD OF ENGINEERS ON THE SHOAL LAKE AQUEDUCT.

DEFECTS in the portion of the aqueduct constructed during the summer of 1915 having been reported to the Administration Board of the Greater Winnipeg Water District, and doubts having thereby arisen as to the cause of these defects, the possibility of repair and the means of avoidance of similar or other defects in the work yet to be constructed, a list of twelve questions were, by resolution of the board, submitted to the consulting engineer, Mr. James H. Fuertes, and to the chief engineer, Mr. W. G. Chace, with instructions to report to the board specifically thereon. Following the receipt of this report and after consideration the Administration Board passed a resolution under which it was decided to secure an independent report on the subject from a board of engineers, consisting of Col. H. N. Ruttan, of Winnipeg; Mr. J. G. Sullivan, chief engineer of the Canadian Pacific Railway; and Mr. R. S. Lea, of Montreal. These gentlemen having agreed to act, they were instructed as follows:—

"That the question submitted, the replies thereto, and the report of the consulting engineer, James H. Fuertes, and the chief engineer, W. G. Chace, thereon, be considered, and any other information procured by the special board of consulting engineers to enable them to report specifically, agreeing or disagreeing with the conclusions or opinions of Messrs. Fuertes and Chace, more especially on all points dealing with (1) the efficiency of design and detail plans for the various portions of the work; (2) the cause of the defects now developed in the work done last year; (3) the practicability of repair, and the probable cost of such repair; (4) the stability and quality of the work done last year; and (5) as to the consulting engineer and chief engineer's proposed method of avoiding a recurrence of any of the present defects or other probable structural defects in the work yet to be constructed."

This board of engineers have held many meetings, visits of inspection have been made to different portions of the work, conferences have been held with Messrs. Fuertes and Chace and the late Commissioner Reynolds, careful and continuous observations were made on the different sections of the work which insured the prompt detection of enlargement or extension of the cracks or the appearance of new ones.

The following extracts from their report would seem to show that any damage which has occurred is not permanent, and seems to settle the rumors which have been a source of anxiety and worry to the Water Board for some time past.

After going into the design and construction of the aqueduct very thoroughly, the general import of their findings is that it is properly designed for the service it is to perform. They furthermore say that the concrete work in general is of high character, and that the designs and plans of the original consulting engineers have not been departed from in principle.

In concluding their report the engineers say:—

The practical questions to be answered in connection with the project are:—

(1) When the aqueduct and its accessories are completed will the works be of such a character that they will satisfactorily perform the service for which they have been designed, viz., the delivery of Shoal Lake water to the city of Winnipeg and the surrounding municipalities in the quantities specified and without pollution on the way?

(2) Will the work as projected be of such a substantial and permanent character as to require only a reasonable charge for maintenance?

(3) Will the cost of the completed work be fair and reasonable?

Subject to the careful carrying out of the work on the lines indicated in this report, all the questions may be answered in the affirmative.

Reference has been made in this report to hydrostatic tests of two of the repaired sections of the aqueduct, in which the loss of water was much below the permissible limit of good practice. Further tests which are being carried on at the present time show still better results.

By the use of steel arch forms and by careful attention to details by the workmen an interior surface of unusual smoothness has been obtained, the effect of which will be to materially increase the discharge capacity of the aqueduct above that estimated. These results could only be obtained with concrete of the highest quality, both as to materials and workmanship.

The cost of the completed work, according to the latest estimate, will compare advantageously with that of similar works anywhere, when the capacity and length of line are considered.

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Approximately three hundred firms in England have been declared "enemy businesses" by the Government, and orders have been given by the Board of Trade requiring them to be wound up. In the list of these firms appear the following names that are more or less known to Canadian engineers: Alphous Custodis Chimney Construction Co., Limited; the Bakelite Co., Limited; Berkefeld Filter Co., Limited; British Ceresit Waterproofing Co., Limited; British Phosphate Co., Limited (owners of phospate bearing lands in Canada); Ferrum, Limited; and Bradshaw Asphalte Co., Limited.

## CANADIAN TERMINAL HARBORS ON THE GREAT LAKES.

BEFORE the recent meeting of the American Association of Port Authorities held in Montreal, Frederick William Cowie, Mem.Can.Soc.C.E., chief engineer of the Montreal Harbor Commission, read a most instructive paper entitled "Canadian Ports." In this paper Mr. Cowie dealt with the ports of Halifax, Montreal and the principles and types of the terminal harbors of the Great Lakes—Fort William and Port Arthur. The first part of his paper dealt very exhaustively with the construction work at Halifax now going on, descriptions of which have appeared in *The Canadian Engineer* for July 30, 1914, and January 6, 1916.

In this article we confine ourselves to that part of Mr. Cowie's paper which deals more specifically with the Canadian terminal harbors at Fort William and Port Arthur.

As the problem of traffic routes from the Lakes to the seaboard has been a very live one for the engineering profession for so many years, it is hoped that this presentation of the subject by Mr. Cowie will be of interest to many of our readers.

The coast line of the Canadian lake ports, extending from Kingston on Lake Ontario, through Lake Erie, Lake Huron, Georgian Bay and Lake Superior to the the United States border at Pigeon River, comprises a total length of about 1,500 miles. In this coast line there are 35 harbors, many of them being excellent examples of local ports. The harbors at Kingston, Toronto, Hamilton, Goderich and Owen Sound hold very important places in the history of Canadian development.

The evolution of lake harbor construction, from the sheltered landing place for schooners to the modern wharves for St. Lawrence type of lake steamer of 2,500 tons and a draught of 14 feet, has necessitated a high degree of skill and enterprise.

From the Atlantic to the Pacific, across country, the distance is approximately 2,600 miles. The distance from the head of the Lakes to the Atlantic Coast is approximately 1,000 miles, or within 300 miles of the central point of Canada.

The Canadian western railways all converge to the head of the Lakes so that the transportation systems may take advantage of the water route during the eight months of open navigation.

Probably the most important economic link in the chain of Canadian transportation system is the twin-terminal harbor at Fort William and Port Arthur, commonly known as the "Head of the Lakes." From this point grain and products of the Northwest are carried—by the water route to Montreal; by the lake and railway route via Canadian lake ports; by full-sized lake vessels to Port Colborne; by full-sized lake vessels to United States ports.

The problem of Canadian transportation, east and west, is of such fundamental importance that the typical harbors of the lake and rail route will be analyzed as showing their economic value, strategic position and types of design and construction.

The twin ports of Fort William and Port Arthur on Lake Superior are therefore chosen as examples, reference also being made to the Georgian Bay Ports of Port McNicoll and Tiffin and to the Welland Canal terminal at Port Colborne.

**Fort William and Port Arthur Harbors Terminals.**—The Hudson's Bay Trading Post at Fort William, on the River Kaministiquia, flowing into Thunder Bay on the northwest shore of Lake Superior, was the starting point of the canoe route for explorers and traders communicating between the provinces of Canada and the Northwest Territories, from the earliest times in the history of that region.

In 1857 the Red River expedition was organized. The object of that expedition was to report upon the best means of opening a line of communication between Lake Superior and the Red River settlement. The Canadian Northwest at that time consisted principally of settlements along the banks of the Red River and the problem of transportation was then, as now, of vital importance.

The reports on the line of route, by S. J. Dawson, Esq., C.E., of 1868 and 1869 record details of explorations extending over several years which resulted in the "Dawson Route."

The original proposition included a road and water route of 131 miles and 332½ miles respectively. It involved several dams and one lock, five transhipment points and a harbor at Thunder Bay, Lake Superior, and the total original estimate was given as $222,400. The harbor works were itemized as "a pier required at the depot, Thunder Bay, Lake Superior, $2,500."

The argument of Mr. Dawson (who later made a name for himself in the parliament of Canada) would be equally sound at the present time. The people of Minnesota constructed stage roads from St. Paul, and practically all the transportation to and from the Red River settlement was taken over this route at a cost of $4.50 to $5 per 100 lbs. Mr. Dawson argued that as it was evident that the trade of the Northwest Territories was of value to Minnesota it ought to be of some importance to Canada. He estimated that by the Dawson route the cost of transportation would be reduced to a maximum of $2 per 100 lbs. and that it was clear that by opening the proposed communication, the trade amounting to several million dollars annually would be transferred to Canada.

The harbor or terminus on Lake Superior was then one of the most important points for decision and the advantages and disadvantages of the Pigeon River, the Thunder Bay and the Nipigon Bay were carefully considered. Improved water routes were then looked for, the question of a railway being argued, but dismissed with the remark that although the ground was not unfavorable, the idea of such a work was premature.

Mr. Lindsay A. Russell, assistant surveyor on the Red River expedition, and later surveyor-general for Canada, located the terminus for the "Dawson Route" in 1858 and 1859, under instructions that it should be accessible to any size of vessel navigating the lakes. He found that a shoal at the mouth of the Kaministiquia limited the draught up the river to 5½ feet, and he assumed that dredging would be continuously required if this channel were deepened. It was also reported that this river froze over at an early date, in the autumn, and that the approaches by roadway to the water-front would be difficult. The terminus or "depot" was therefore located three miles to the eastward of the mouth of the river, beyond the shoal, where it was reported that "vessels of ocean draught could lie at an ordinary wharf extending 500 feet out from the shore."

The depot was re-named Prince Arthur's Landing after the Red River expedition in 1870, in honor of Prince Arthur, now Field Marshal His Royal Highness the Duke of Connaught, late Governor-General of Canada, who, serving with his regiment, accompanied the expedition. The name is now Port Arthur.

The location of the harbor at Port Arthur, resulted in the construction of a breakwater in 1868, and of the beginning of the harbor works which are now of such considerable extent and great importance.

The projected line of railway from the province of Ontario and Quebec to the Pacific Coast again renewed, from the point of view of railway transportation, the question of the Canadian port on the northwest shore of Lake Superior. Mr. Sanford Fleming, engineer-in-chief, first reported in 1872 and again in 1874 and 1877, that the principles laid down in connection with the route involved a line "which would touch Lake Superior at such a point in its course as would make the prairie region accessible from the lake during the season of navigation." This resulted in the serious consideration by the railway engineers of another proposed terminus on Lake Superior, *viz.*, Nipigon Bay.

As against the propositions in Thunder Bay, Nipigon Bay almost had the call for the terminal harbor. Fortunately for the "Lake and Rail Route" this was not accepted, as it would have involved a longer rail haul, without greatly shortening the water route, and therefore decreased the economic value of the Canadian route.

The final location was apparently settled by the fact "that the navigation of Lake Superior could, at a trifling cost, be extended from Thunder Bay up the River Kaministiquia to a point about eight miles above Prince Arthur's Landing" to West Fort William, which was satisfactory.

The original contract for the Canadian Pacific Railway, from the head of lake navigation, as described by Sanford Fleming in 1876, "commenced at a point on the north bank of the River Kaministiquia, 604 feet above the level of the sea, the line taking a northwest course, the maximum gradient being 1 in 100." The first locomotive engine was landed at Fort William in August, 1876, just 40 years ago.

Improvements to the Prince Arthur's Landing harbor, as it was originally called, were commenced as public works of Canada, in connection with the "Dawson Route," and to the River Kaministiquia shortly after the projection of the Canadian Pacific Railway.

"Our bay is very deep, in some portions, I am told by some of our fishermen, from 200 to 300 fathoms. Our docks are four, with only an average depth at furthest out cribs of 14 feet or so. This harbor is not yet closed. A tug with 150 tons of freight on a scow from Duluth mines arrived yesterday morning, discharged this evening and is now loading a cargo of fresh fish for Duluth, and will leave to-morrow forenoon."

(Signed) "Collector."

(Dated) "Prince Arthur's Landing, 28th Dec., 1882."

**Fort William Harbor.**—At Fort William the harbor consists almost exclusively of riverside quays. The River Kaministiquia has three distinct channels or outlets. There are wharves at the mouth of each channel and at the junction of the Mission Channel with the main river there is a turning basin and another 6½ miles up, with wharves and terminals on each side. The channels have been dredged to a depth of 25 to 30 feet.

Coal docks, elevators, oil docks, flour mills, industrial works and freight and passenger wharves are located on the different branches of the river up as far as five miles.

The width of the Kaministiquia Channel is 600 feet, the Mission Channel 50 feet and the McKellar Channel 400 feet, and the depth at the wharves 25 feet.

The total water-front of these splendid land-locked harbor channels is about 26 miles.

**Port Arthur Harbor.**—Port Arthur harbor is situated on the north shore of Thunder Bay, adjoining and to the eastward of Fort William harbor. Although Thunder Bay is not large, breakwaters have been constructed to form the perfect protection required for vessels operating at the various wharves and terminals.

The works of the Western Dry Dock Co. are situated at the extreme eastern limit of the harbor.

The shipyard at Port Arthur is very well equipped for the construction of lake vessels of the largest size and also for the building of passenger and freight boats. The "Noronic," length 385 feet by 59 feet, with passenger capacity of over 600 cabin passengers, tonnage 6,000, was built in the shipyard at Port Arthur. The shipyard, it is stated, has a capacity for building lake vessels of 14,000 tons burthen and 625 feet long.

There are a number of wharves of different lengths; the Canadian Pacific Railway wharf, 990 feet long, 75 feet wide, shed upon it 400 feet long; the Canadian Northern Railway wharves have been recently extended in length and size, five railway tracks alongside; the Fisher's wharf, 700 feet long by 40 feet wide, with ice-house and packing-house upon it; Clevat's wharf, 770 feet long by 55 feet wide, with two storehouses and shed. The coal wharf is 930 feet long; the Canadian Northern Railway wharf, 800 feet long, with freight shed upon it and railway track alongside. The Canadian Northern Railway Company has a coal dock with a storage capacity of 650,000 tons and at which a large quantity of coal can be discharged in 10 hours by the plant.

As an important link in the transportation system, the government has given generous aid towards the development of these twin ports—breakwaters, aids to navigation, dredging, turning basins and public elevators.

The Canadian Grain Commission created for the purpose of studying, investigating and reporting on matters connected with the collection, inspection, transportation and storage of grain have their headquarters at this "Head of the Lakes." This commission has fulfilled a public service of inestimable value, and in view of the growing future of the Northwest, its labors have only just begun. Their work is within the view of the farmer, who is keen to forward his products to market to the best fraction of a cent of advantage, and this commission, with its extensive powers and active organization, had boldly attacked and overcome many of the difficulties of despatch and economic transport.

There is no comprehensive authority in either or both of these important harbors.

The Canadian Government aids in keeping navigation open as long as possible by operating ice-breaking vessels.

Up to the present, the unit system has prevailed. Each city, each railway, each terminal elevator, each protection work and each wharf are self-contained. The result is that there are splendid units competing with each other, and giving most remarkable results. Such efficient and economical units co-operating and interchanging, would without doubt, give the best possible example of an economical feature of the Canadian transportation problem.

**Progress of the Twin Cities.**—The following table of population of the cities of Fort William and Port Arthur shows the phenomenal growth of these cities, almost all of which may be attributed to the harbor terminals and transportation features:—

| | Fort William. | Port Arthur. |
|---|---|---|
| 1901 .................... | 3,633 | 3,214 |
| 1911 .................... | 16,499 | 11,220 |
| 1916 .................... | 20,854 | 12,500 |

The authorities state that as a result of the war the population in 1916 is very much reduced, as compared with 1914.

**The Industrial Situation.**—The manufacturing industries located at Fort William and Port Arthur have expanded to a wonderful degree in the past few years. Warehouses and assembling plants, and the works of the Western Dry Dock and Shipbuilding Co. all add to the business of the ports and their success.

**Approaches to the Harbors.**—For the largest, and most severe as regards weather conditions, the harbor situation is well nigh perfect. Vessels approach the wide entrance to Thunder Bay with perfect security. Once inside, local security may be found from any storm.

By railway the grades eastward, in the direction of heavy traffic, are favorable.

**Harbor Improvements.**—The physical conditions are favorable for harbor design and construction. Weather conditions and the character of the small river entering the harbor render up-keep and maintenance possible at small cost. Expansion to any degree is quite possible.

The future possibilities of the port are equal to the immense probabilities of increased traffic.

**List of Grain Elevators at Fort William and Port Arthur.**—Fort William: C.P.R. Elevator "D", on Kaministiquia River. Erected 1897-1914; (on C.P.R.); total storage capacity, 7,250,000 bushels; operating capacity per hour: in by cars, 25,000 bushels; out to vessels, 200,000 bushels.

Empire Elevator Co.'s elevator, at mouth of Kaministiquia River. Erected 1904; (on C.P.R.); total storage capacity, 1,750,000 bushels; operating capacity per hour: in by cars, 10,000 bushels; out to vessels, 40,000 bushels.

Grain Growers' Elevators "B" and "E", on Kaministiquia River. Erected 1902-1906; (on C.P.R.); total storage capacity, 2,500,000 bushels; operating capacity per hour: in by cars, 12,000 bushels; out to vessels, 25,000 bushels.

Eastern Elevators "A" and "C" on Kaministiquia River. Erected 1890; (on C.P.R.); total storage capacity, 2,235,000 bushels; operating capacity per hour: in by cars, 10,000 bushels; out to vessels, 30,000 bushels.

Fort William Terminal Elevator "F" on Kaministiquia River. Erected 1913; (on C.P.R.); total storage capacity, 3,250,000 bushels; operating capacity per hour: in by cars, 12,000 bushels; out to vessels, 45,000 bushels.

G.T.P. Elevator, at mouth of Mission River. Erected 1910-1912; (on G.T.P.); total storage capacity, 5,750,000 bushels; operating capacity per hour: in by cars, 24,000 bushels; out by vessels, 120,000 bushels; out by cars, 150,000 bushels.

Consolidated Elevator Co.'s elevator on Kaministiquia River. Erected 1906-1910; (on C.P.R.); total storage capacity, 1,760,000 bushels; operating capacity per hour: in by cars, 10,000 bushels; out to vessels, 30,000 bushels.

Ogilvie's elevator, on Kaministiquia River, opposite McKellar River. Erected 1904-1907-1909-1915; (on C.P.R.); total storage capacity, 2,000,000 bushels, operating capacity per hour: in by cars, 2,000 bushels; out to vessels, 25,000 bushels.

Western Terminal Elevator, on Kaministiquia River. Erected 1909-1914; (on C.P.R.); total storage capacity, 2,000,000 bushels; operating capacity per hour: in by cars, 12,000 bushels; out to vessels, 35,000 bushels.

Muirhead-Bole Elevator, corner Pacific Avenue and Athabasca. Erected 1911; (on C.P.R.); total storage capacity, 35,000 bushels; operating capacity per hour: in by cars, 2,000 bushels; out by cars, 2,000 bushels.

Paterson's Elevator "K", Montreal Street. Erected 1912-1913; (on C.P.R. and G.T.P.); total storage capacity, 80,000 bushels; operating capacity per hour: in by cars, 2,000 bushels; out by cars, 2,000 bushels.

Paterson's Elevator "O", on Kaministiquia River, foot of Heath Street. Erected 1914; (on C.P.R.); total storage capacity, 100,000 bushels; operating capacity per hour: in by cars, 2,400 bushels; out to vessels, 15,000 bushels. When addition of 100,000 bushels is completed the capacity per hour out to vessels will be 25,000 bushels.

Superior Elevator, Mary Street. Erected 1913; (on C.P.R.); total storage capacity, 110,000 bushels; operating capacity per hour: in by cars, 3,000 bushels; out by cars, 3,000 bushels.

Western Elevator "G", on Kaministiquia River. Erected 1915; (on C.P.R.); total storage capacity, 70,000 bushels; operating capacity per hour: in by cars, 2,000 bushels; out by vessels, 5,000 bushels, or out by cars, 2,000 bushels.

Black and Muirhead Elevator, on Kaministiquia River. Erected 1909-1914; (connected direct with C.P.R., C.N.R. and G.T.P. by private track); total storage capacity, 180,000 bushels; operating capacity per hour: in by cars, 1,400 bushels; out to vessels, 20,000 bushels.

Bole Grain Company Elevator, on Hardisty Street. Erected 1912; (on C.P.R.); total storage capacity, 20,000 bushels; operating capacity per hour: in by cars, 1,000 bushels; out to cars, 1,000 bushels.

Dwyer Elevator, on Kaministiquia River, Island No. 2. Erected 1913-1915; (on C.P.R.); total storage capacity, 250,000 bushels; operating capacity per hour: in by cars, 2,000 bushels; out to vessels, 10,000 bushels.

Guys Elevator, corner Atlantic and Athabasca Streets. Erected 1912; (on C.P.R.); total storage capacity, 35,000 bushels; operating capacity per hour: in by cars, 2,000 bushels; out by cars, 2,000 bushels.

Port Arthur: National Elevator, Second Avenue. Erected 1915; (on C.N.R.); total storage capacity, 50,000 bushels; operating capacity per hour: in by cars, 2,500 bushels; out by cars, 4,000 bushels.

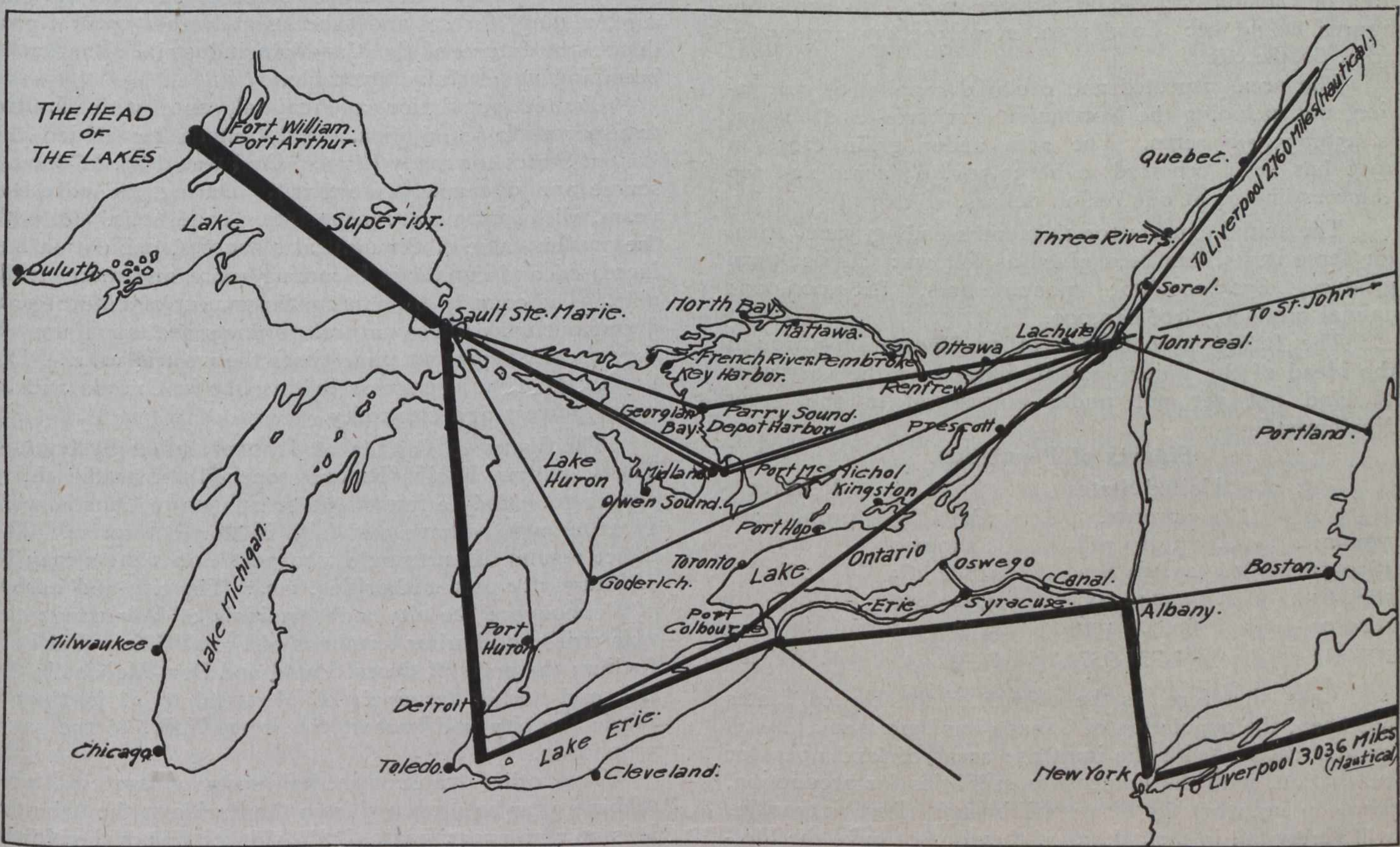
Davidson and Smith Elevator, on Thunder Bay at mouth of McIntyre River. Erected 1914; (on C.P.R. and C.N.R.); total storage capacity, 750,000 bushels; operating capacity per hour: in by cars, 8,000 bushels; out to vessels, 40,000 bushels.

Horn & Co.'s Elevator, on shores of Thunder Bay. Erected 1882; (on C.P.R.); total storage capacity, 750,000 bushels; operating capacity per hour: in by cars, 4,000 bushels; out to vessels, 10,000 bushels.

Canadian Government Elevator, on shore of Thunder Bay at mouth of McIntyre River. Erected 1913; (on C.P.R. and C.N.R.); total storage capacity, 3,250,000 bushels; operating capacity per hour: in by cars, 40,000; out to vessels, 75,000 bushels.

Canadian Northern Elevator, on shores of Thunder Bay. Erected 1903-1904-1912-1913; (on C.N.R.); total storage capacity, 9,250,000 bushels; operating capacity per hour: in by cars, 24,000; out to vessels, 280,000 bushels.

Empire Company's Elevator, Thunder Bay, near mouth of McIntyre River. Erected 1909; (on C.N.R.); total storage capacity, 1,500,000 bushels; operating




**Grain Routes from the Head of the Lakes.**

capacity per hour: in by cars, 12,000 bushels; out to vessels, 40,000 bushels.

| | ——Grand Totals—— | | |
|---|---|---|---|
| | Storage capacity. (Bushels.) | In, per hour. (Bushels.) | Out, per hour. (Bushels.) |
| Fort William .... | 29,375,000 | 140,000 | 640,000 |
| Port Arthur ..... | 15,550,000 | 90,500 | 449,000 |

**The Romance of Grain Shipments from the Head of the Lakes.**—The total shipments from Fort William and Port Arthur, for all grains, are recorded as follows:—1900-01, 6,500,000 bushels; 1904-05, 31,000,000 bushels; 1913-14, 201,500,000 bushels; 1915-16 (for year ending July 31st, 1916), 335,000,000 bushels.

**Area and Resources of Canada.**—The total known area of Canada is 3,729,665 square miles. In acres the figures would be: Land area, 2,306,502,453 and water area, 80,482,942.

The area inspected and declared capable of cultivation, not including the Northwest Territories and Yukon, is 358,835,000 acres. The area under grain crops in 1916 has been reported to be 33,591,365 acres and the value estimated at one billion dollars.

The actual exports for 12 months ending June, 1916, for three items, has been given as follows: Agricultural produce, $323,000,000; manufactures, $284,000,000; animal produce, $108,000,000.

The future probabilities of transportation through the Head of the Lakes may be judged by the vast area of land not yet put under cultivation in the great Northwest.

**Figures of Population.**

| | United States proper. | Canada. | Relative proportion. |
|---|---|---|---|
| 1800-01 ...... | 3,929,328 | 240,000 | 6% |
| 1850-51 ...... | 23,191,876 | 1,842,265 | 7% |
| 1880-81 ...... | 50,442,066 | 4,324,810 | 8% |
| 1900-01 ...... | 66,809,196 | 5,371,315 | 8% |
| 1910-11 ...... | 81,731,957 | 7,206,643 | 8% |

Vast, therefore, as the growth of the United States has been, the population of Canada has increased at a still greater rate. With the immense areas of land open for cultivation, with the immense possibilities for production, who can say what the future will bring? Port authorities will surely fail in their duties if they do not have the foresight to realize what will be required in 10 or in 25 years, and they would do well not to plan projects or build ports which may not be modified to suit the requirements of even the more distant future, with its certain need.

That the agriculture value of Canada's western areas will continue may be judged by the statement that the first foot in depth of soil of the three western provinces—Manitoba, Saskatchewan and Alberta—is worth more than all the mines in the mountains from Alaska to Mexico, and more than all the forests from the United States boundary to the Arctic Sea. And next in value is the three feet of soil which lies underneath the first foot. The land may be tilled for twenty successive crops without much diminution of yield, owing to the richness and depth of the subsoil.

The extent and value of the forests of Canada are well known. Conserved and properly cut and manufactured, they may be considered as an important stable future factor in the progress and trade of Canada.

A conservative estimate of the forest lands is given as 450,000,000 acres and a stable annual production of $100,000,000.

The mineral wealth of Canada is also becoming a matter of increased surprise. Canada was formerly known to be rich in coal, iron, gold and silver. In the last few years, however, the yields of copper, nickel, lead, asbestos, natural gas, petroleum, cement clays, stone, gypsum and the many by-products have resulted in most gratifying returns and have added new sources of revenue to the ports of Canada.

The fisheries of Canada are every year increasing in value and importance. With rapid communication between northern ports on both the Atlantic and Pacific, and also with fishing stations on Hudson's Bay and the Great Lakes, and improvements in refrigeration, the value and commerce in the fishing trade is one of the important resources of Canada.

With special features of resources such as agriculture, mining, forests and fisheries and other natural products, the future of the Canadian industrial situation is becoming wonderfully favorable.

Limited population and capital, and with limited transportation conditions, held Canada far behind the United States for many years. Coal was dear, labor was scarce and distances were great. During the past few years, with improved transportation conditions, and with the proven value of the natural resources, population has increased and capital is becoming more and more available. The country benefits by the export of natural products, but when those natural products are manufactured they usually represent three times the natural value. The key to the assured success in this line in Canada will be water powers and electricity.

**The Value to Canada of Transportation Systems.**—The Canadian Pacific Railway opened for traffic thirty years ago. Only a few of the great men in Canada were great enough to have real faith in that enterprise. The direct results of one single transportation system may be of interest to port authorities, *viz.*: The city and harbor of Vancouver; the city and terminals of Winnipeg; the twin cities and harbor terminals of Fort William and Port Arthur; the ports of Owen Sound and Port McNicoll; the city and harbor terminals of Montreal to at least one-third; the city and harbor, St. John, N.B., to the same proportion.

Two other transcontinental railway systems have within a year been opened from the Pacific to the Atlantic. It is now no experiment. If Providence favors the Northwest as in the past, the next thirty years should see the above cities and harbors trebled and twice as many others built up to their present degree.

That is the *raison d'etre* of the Canadian transportation projects and the Canadian ports.

Transportation through the country and ports, economical terminals, well-equipped ports, industrial enterprises, all thoroughly investigated by the best brains available and carefully carried out, may be given as the Canadian programme.

The harbor terminal at the Head of the Lakes has been carefully and wisely located. Government, corporate, municipal and private interests have evolved, in thirty years, splendid harbors, magnificent railway terminals, flourishing cities, and successful enterprises. The "Head of the Lakes" has no competitor. If it had a rival, would port authorities, whose knowledge results from ascertained facts relative to economic transportation, ask the questions: Why two adjoining city organizations? Why two ports? Why three independent railway harbor terminals? Why twenty-three independent ter-

*(Continued on page 301.)*

## STANDARDIZATION AND ITS ASSISTANCE TO THE ENGINEERING INDUSTRIES.

IN a paper before section G (Engineering) of the British Association, Mr. C. Le Maistre (secretary of the Engineering Standards Committee), after relating the circumstances in which the committee came to be formed and its method of working, went on to speak of the success of the movement towards a greater degree of standardization. He said one of the first objects in the formation of the committee was to simplify the rolling of steel sections for engineering structures and rails as well as shipbuilding material, so as to save unnecessary cutting of a variety of rolls for no good reason and also to facilitate the making to stock during slack times. That the work of the committee in this direction had been amply rewarded was shown by the fact that the number of rolls in use by British manufacturers had been largely reduced. As an instance, whereas there were formerly 70 sections of tramway rails, there were now only five. The same was true of all ordinary merchantable sections such as angles, tees and channels and rolled joists. The percentage of British Standard tramway rails to the total tonnage rolled during the year ending March, 1915, was 75 per cent., which was an indication that the number of standards recommended was adequate to meet all ordinary requirements. A considerable reduction had similarly been effected in regard to railway rails, and that the work of the committee was of material benefit to the railway companies was evident from the wide adoption of its findings and the substantial manner in which they financially supported the committee's activities.

Turning to the case of Portland cement, the British standard was now generally adopted by engineers and manufacturers throughout the whole country, and the large number of copies of the specification which has been sold—3,500 copies since the 1910 revision—went to show its general utility to the industry. In 1913 the output of Portland cement in England was over 3,000,000 tons, 95 per cent. of which, it was estimated, was made to British standard.

The London County Council, in its General Powers Act, 1909 (Part 4), amending the London Buildings Acts so as to provide for the construction of steel-frame buildings, had required that all rolled steel used in the construction of skeleton frameworks of buildings shall comply with the British Standard Specification for Structural Steel for Bridges and General Building Construction, and that all brickwork, concrete, stone, and other similar materials used in conjunction with the metal frameworks shall be executed in cement conforming with the British Standard Specification for Portland Cement.

It was estimated that 60 per cent. of the material used in the manufacture of railway rolling stock in Great Britain was made to British standard. It would also appear from returns that in five of the largest steel works during 1913-14 the British standard sections totalled 95 per cent. of their output. The sections recommended by the committee for structural steel might be had from practically all the steel works in the country.

The Admiralty had adopted the British standard specification for steel for marine boilers, where steel of the tensile strength dealt with therein was required, the British standard specification for structural steel for shipbuilding, and, subject to certain additional requirements made necessary by the special character of naval work, the British standard specifications for steel castings and forgings for marine purposes. The Admiralty had also decided to adopt the British standard fine threads (Report No. 20) for all bolts, nuts and studs for marine work generally, and the War Office had specified them in many cases. The War Office had also adopted the British standard rim diameters for solid tires (Report No. 71).

The Board of Trade rules for the survey of passenger steamships were in accordance with the British standard specifications for boiler steel, ingot steel, forgings and steel castings. Lloyd's register had adopted the British standard sections, and the standard specifications for steel for shipbuilding and marine boilers, for steel castings and forgings for marine purposes, and had incorporated these in its rules. The British Corporation for the Survey and Registry of Shipping, and the Bureau Veritas, had likewise given effect to the committee's recommendations in their rules.

The Admiralty had, moreover, taken the keenest interest in the electrical work and, in nearly all cases, had adopted the electrical specifications of the committee, except where the exigencies of the service required departures owing to the special conditions which had to be met at sea.

The Indian government and Indian government railway companies, besides adopting the specifications of the committee for manufactured work, requested in 1903 that the standardization of types of locomotives be undertaken by the committee, and, in all, six broad-gauge and four metre-gauge engines had been standardized, and at the further request of the Indian government designs for three more standard engines were in preparation. Since the issue of the first report in 1905 more than 1,600 standard broad-gauge and 700 standard metre-gauge engines, representing roughly about 7½ millions sterling, had been built for India. Criticisms had sometimes been heard in regard to this policy of the Railway Board of India, but over ten years of practical experience had evidently demonstrated the wisdom and economy of this policy, which might, with advantage, be followed by our home railways. Crystallization of design and stagnation had clearly been avoided by the policy of a standing committee reviewing its recommendations at stated periods and adopting modifications as and when deemed necessary.

The Home Office, in a memorandum on chains and lifting devices, noted the increased use of the two higher grades of wrought-iron recommended by the committee, and encouraged their general adoption by chain-makers. Also in a recent order-in-council the Home Office required that the wattage of tungsten-filament lamps used for automobiles should be limited to the maxima given in the committee's report dealing with that subject.

Turning to the electrical side of the committee's activities, it was interesting to note the large amount of preparatory work of importance which had been successfully carried through during the past two years. The most important electrical work completed was that of the standardization rules for electrical machinery, in the preparation of which the committee had received the cordial co-operation of the British manufacturers through their official organization.

The conditions of the electrical industry in this country were very different from those existing in Germany or America. In the United States two large corporations dealt with practically the whole of the business, whereas in England there were some 40 of 50 firms more or less in competition with one another. However, conferences held both in London and in New York with the standards committee of the American Institute of Electrical Engineers has resulted in the establishment of a thoroughly practical basis for the comparison of tenders for electrical machinery made in the United States of

America or Great Britain, the rules of both countries being now in agreement on all essentials.

Much also had been accomplished in one of the most difficult of tasks, the standardization of small electric fittings with due regard to liberty of design. This work, in which again the makers' association had been most helpful, had occupied a great deal of time, and the difficulties and prejudices to be overcome had been great. Ordinary household wall-plugs and sockets had at last been standardized as regards interchangeability. A specification to secure interchangeability between any charging plug and any socket of the type recommended by the Electrical Vehicle Committee of the Incorporated Municipal Electrical Association should be of material assistance in promoting the use of electric wagons and runabouts. A specification for electric supply meters had recently been evolved after much labor, and although some modifications might still be required, it was hoped that it might be eventually proved satisfactory to both producer and purchaser alike.

A system of British standard graphical symbols for use in electrical engineering plans was being drawn up, and in this work the committee had the co-operation of the American and Canadian electro-technical committees.

The ramifications of the committee, as would be seen from the cases cited, were extremely widespread, and the commerce of the world, due to the increasing ease of communication, being largely international, one might almost say, in spite of the artificial barriers set up by different nations, it was natural that the committee should be forced to envisage co-operating internationally. The sectional electrical committee, with a different chairman, was *ipso facto* the British committee of the International Electro-technical Commission which had branch committees in fifteen to twenty different countries.

The complex nature of electrical machinery called for different treatment, from the point of view of standardization, than in the case of other engineering materials. Indeed, the problem of the rating of electrical machinery was possibly more intricate than was the standardization of any simple pieces of mechanism, electrical or otherwise. The conductivity of the copper, the permeability of the iron, the mechanical strength of the materials, could be estimated with sufficient accuracy from the results of definite and easily carried out tests on samples. When the question of insulating materials, however, was considered, the problem was, of course, very different, and one could but acknowledge that, owing to their inherent properties, the insulating materials employed at present came into an entirely different category. They were governed by no well-defined laws, as in the case of the copper and iron; their properties were variable and altered largely for very small changes in the conditions of manufacture, as well as those under which they were employed in the completed machine. One of the important problems, therefore, was the settling of the limits which it was considered necessary to impose in order to ensure that the principal causes of destruction of the insulating materials, the heating combined with the time element, should be well kept within safe limits.

A clear distinction existed also between an "international standard of quality" and an "international rating." The international acceptance of the former had already been brought about by the adoption, by the I.E.C. at its Berlin meeting in September, 1913, of certain limits of observable temperature applying to the materials in general use to-day. But these limits did not offer a means of comparing directly machines from various sources, since they would not necessarily have the same temperature rise. The fact, however, that American and British electrical engineers were at one on this point of immense commercial importance would doubtless have a great influence on the electrical industry of the world.

On all sides there were signs of strenuous preparations for meeting conditions after the war; science and industry were coming closer together, the commercial and technical sides inseparably linked together, were being more efficiently organized, research work to assist manufacturers was being co-ordinated, finance was organizing, combinations of commercial organizations were in the air; in fact, everything was being done with a view to strengthen British industry.

The German League of Economic Associations, recently formed out of the six great associations of German engineers, architects, furnace men, chemists, electricians and marine engineers, numbering, so it was said, some 60,000 members, was an indication of what might be expected. Every effort must, therefore, be made to ensure that the British standard specifications were readily available to foreign purchasers as well as to those in the British Empire. A few of the specifications had already been translated into French, and it was hoped that satisfactory arrangements might be made to translate them all into French as well as into Spanish. In regard to Russian, the question was somewhat complicated, but in this case also the matter was being given the most careful consideration.

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## THE AQUEDUCT FOR THE GREATER WINNIPEG WATER DISTRICT.*

**By W. G. Chace, M.Can.Soc.C.E., and M. V. Sauer, M.Can.Soc.C.E.**

THE aqueduct structure itself has been designed to be built in two operations, first the invert, and second the arch. Alternate sections of the invert are built in lengths of 15 feet, and after several of these have been placed, the intermediate or closure sections are completed. Steel end forms or "profiles" shaped to the curve of the invert are accurately set to line and grade on 15-foot centres, and the concrete of rather dry consistency is placed between them and then screeded to shape with an angle iron screed. After this operation the surface is floated and surfaced to a smooth, hard finish. Between adjacent 15-foot sections of invert a water-stop consisting of a No. 20 gauge copper strip 6 inches wide and of a length equal to the width of the invert is placed. Each strip has a V-shaped groove one-half inch in depth crimped in the centre of the strip, running its full length, thereby allowing the joints to open without breaking the bond between the concrete and copper.

After the invert concrete has become hard the arch forms are then erected by means of a steel traveller running on a narrow-gauge track placed on the invert. These forms are of the Blaw collapsible type made in lengths of 5 ft. 0 in., bolted together to give a total length of 45 ft. 0 in., which is the standard length of arch poured at one time. Water-stops similar to those in the invert are placed at 45-foot centres in the arch to protect against leakage at the contraction joint. At the horizontal joint between the arch and invert a continuous strip of soft wood 7/8 in. x 1 1/4 in. is placed half in the

*Abstracted from paper before the Canadian Society of Civil Engineers, Thursday, October 5th, 1916.

invert and half in the arch concrete. Numerous tests made on the sections of the aqueduct already built show that these provisions for making the joints watertight are satisfactory. At no point has any leakage been observed other than a slight dampness in a few instances at the junction of the four joints between arch and inverts.

The aqueduct in its course crosses several streams and rivers and in all cases the crossings are made by depressing the structure beneath the river beds. These sections being under pressure are made circular of reinforced concrete. Overflow and blow-off structures have been provided in the aqueduct at the upstream sides of most of the river crossings which will serve the purpose of governing the discharge as well as for providing outlets for the water and drainage thereof for the purpose of emptying portions of the aqueduct for cleaning. The discharges from these overflows enter into the rivers. It will be noted that provision has been made for the entering and removal of a small-sized boat which can be used in the aqueduct for purposes of inspection at times of partial discharge. These overflow structures have all been designed for withstanding a heavy backfill in case it may be found necessary as a protection against frost. It is not anticipated, however, that such protection will be required, as the walls have been provided with double windows and doors, and all openings into the aqueduct are provided with movable covers, the building itself thus forming a closed air space between the aqueduct and the outside air. The exposed metal work in these structures as well as all metal work pertaining to the aqueduct subject to corrosion is of bronze. Boat entrances, separate from the overflow structures, have been provided at various points along the line. Concrete manholes carried up to the surface of the backfill, and provided with heavy cast-iron covers, specially locked, have been located at intervals of one mile along the aqueduct. An inner concrete slab cover has been placed in each manhole 18 ins. below the outside cover, and a bench mark has been set in the wall provided with a brass tag on which the station and elevation can be stamped.

Two Venturi meters have been laid out—one downstream from the intake, and forming part of the depressed section under the Falcon River, and one immediately adjacent to and east of the site of the future reservoir at Deacon. These meters will be formed generally of reinforced concrete, provided with bronze throat rings. Instead of using a continuous ring for the upstream piezometer casting, separate bronze plates spaced equi-distant about the periphery at the upper end of the entrance cone, have been designed, each plate being connected by a separate pipe to a central manifold or header located in the adjacent chamber erected for the recording and integrating apparatus. It is believed that several advantages are obtained by the use of the separate plates over the continuous ring, not the least of which is the less cost. In meters of similar description it has always been found difficult to maintain a large ring in a true circle, and when the necessary bracing has been erected it interferes greatly with the form construction so that it has been difficult to get a smooth and unobstructed joint between the concrete and the face of the bronze ring. By the use of separate plates it is believed that this difficulty will be entirely obviated since the forms can be first trued up to accurate shape and then the plates bolted to the form without danger of displacement. Another advantage in this arrangement lies in the fact that by having a separate pipe between the chamber and each piezometer, any one hole that becomes blocked up can be simply blown out.

**Supply Line Between Reservoir Site and Winnipeg.**—The construction of a reservoir of 250,000,000 Imperial gallons capacity, to be located at a point "south-east of Transcona," was recommended by the consulting engineers, not as a present requirement, but for some future date when warranted by the growth of the District. It was also advised that the aqueduct at the present time be extended from this point known as "Deacon" to the present McPhillips reservoirs in Winnipeg as a 5-ft. 0-in. diameter steel pipe line capable of giving a discharge by gravity to the District of 25,000,000 Imperial gallons per day, which later on could be increased when this demand shall be exceeded by pumping at Deacon, or by the installation of additional pipe lines. Deacon thus marks the west end of the gravity aqueduct.

All the conditions entering into this arrangement have been carefully analyzed during the past two years, and these studies have shown the advisability of using a reinforced concrete pipe 5 ft. 6 ins. in diameter in place of the 5-ft. 0-in. steel pipe as recommended. The reasons for the change can be summed up briefly as follows:—

1. Cost.—A study of the difference in actual cost per foot between a 5-ft. 0-in. steel pipe and a 5-ft. 6-in. reinforced concrete pipe based on recent prices for both labor and material shows that the cost of the concrete pipe is some 15 per cent. less than that of the steel pipe.

2. Capacity.—The capacity of the 5-ft. 6-in. concrete pipe is estimated to be more than 47 per cent. greater than that suggested for or possible with the 5-ft. 0-in. steel pipe between Deacon and the Red River, under the heads available, thus postponing for several years the necessity for the installation of a pumping plant. The additional capacity gained is due both to the increase in size and to the smoother surface.

3. Length of Life.—The length of life of the reinforced concrete pipe can be safely assumed as 100 years. As a matter of fact, if the pipe is kept free from electrolytic action, there is no reason to suppose that it will not last indefinitely under the conditions obtaining here. In the case of the steel pipe its usefulness would be practically gone by the time the necessity for a pumping station at Deacon should arise, so that the cost of a new pipe replacing the first one would have to be carried as well as the cost for the pumping plant.

4. The principal cost of a concrete pipe is in labor and by building it of concrete, the money goes back to the citizens of the District, whereas if built of steel the greater portion of the money expended would not only go outside of the District, but probably out of the country. The materials for the reinforced concrete pipe would be all of Canadian manufacture.

5. On account of the severe side thrust from the walls of the trench consisting in great part of a slippery clay the concrete pipe lends itself to a more rational design than one of steel plate.

6. The Act of the Manitoba Legislature incorporating the Water District does not provide, as was evidently anticipated by the Board of Consulting Engineers when drafting their report to the city of Winnipeg in August, 1913, for delivery of water under pressure for distribution to the several municipalities of the District, and it therefore became possible to design this pipe line from Deacon to the Red River crossing on purely engineering lines.

The pipe will be carried in practically direct line from Deacon to the outskirts of St. Boniface in a trench excavated to a depth of from 10 to 16 feet. It will be extended to the east bank of the Red River under the streets of St. Boniface, crossing underneath the Seine River en route. The line will be carried under the Red River through a tunnel excavated well down in the rock beneath the river bed. Borings are now being made to determine the nature and depth of the rock strata underlying the river. From the west bank of the river the line will be extended to McPhillips Street reservoir, probably as a 4-ft. cast iron main laid under the streets of Winnipeg.

A pumping plant will be located at a future date at the Red River tunnel, and from this point future lines can be extended when the capacity of the gravity supply beyond this point shall have been exceeded. By this arrangement the pumping plant will be located near the centre of gravity of the District.

It may be mentioned here that the location of the reservoir is some two miles further east than contemplated in the Consulting Engineers' original layout, due to the location of the final aqueduct line. For this reason the 5-ft. steel pipe would not be sufficient to carry by gravity 25,000,000 gallons into McPhillips Street, but would require to be 5 ft. 3 ins. in diameter.

**General Features of Construction.**—The right-of-way, 300 ft. in width (except for the easterly 12 miles which is 500 ft. in width), was cleared by contract in the winter and early spring of 1914.

A standard gauge railroad was constructed 40 ft. from the south boundary of the right-of-way during the season of 1914 at a total cost of $1,325,000. The construction of the railroad presented no unusual difficulties, and was carried out with such dispatch that trains were operating over the whole of it in January, 1915. The present equipment consists of four 60-ton Mogul locomotives, forty 20-yard air dump steel cars, twenty-five 16-yard air dump steel cars (now under contract), twenty flat cars, ten box cars, three cabooses and two passenger coaches. Additional equipment is being purchased.

**Methods of Aqueduct Construction.**—There is considerable variation in the methods of handling the work. On contract No. 30 the excavation is carried out with teams and scrapers and by means of a walking dredge, the cut on this section being comparatively shallow and on the open prairie. The final trimming of the bottom of the trench is done by hand immediately before the invert concrete is placed. This hand trimming is required on all contracts and is done to prevent any possibility of the soil drying out and cracking, and thus forming a spongy bed for the foundation. The walking dredge is a heavy timber trussed structure spanning the trench and provided with a forward dumping dipper excavator. It is provided with six timber pads, one on each corner and one intermediate pad on each side. By means of chains and winches the weight is shifted from the corners to the centre pads and the whole structure is pushed forward by chains working on the legs of these pads. The dredge is driven by a gasoline engine operating, through clutches and belts, the various movements. The concrete plant on contract No. 30 is placed on a flat car operated on a track built alongside the trench. Materials are fed to the mixer from the storage piles alongside the District track by means of a travelling, stiff-legged derrick operating on a track midway between the railroad and the aqueduct trench.

A somewhat similar method of mixing and placing concrete is carried out on contract No. 31, but the excavation in this case is being done partly by stationmen and partly by Thew steam shovels, mounted on trucks, and specially built to work in the narrow trench, and to deposit the excavated material on the side.

The excavation on contracts Nos. 32, 33 and 34, most of which is in clay overlaid with muskeg material, is carried out by means of specially designed drag line excavators. These excavators are provided with superheaters in order that full economy may be obtained from the coal. The drag lines stand at the end of the trench and work backwards, the bucket being dragged towards the machines and then swung out to the side of the trench. They dump the material along the south side in most cases to form an embankment upon which a narrow-gauge construction track is placed for carrying trains of cars containing mixed concrete to the work. The draglines are supported on the bogs by means of plank platforms made in sections each 8 ft. 0 in. x 20 ft. 0 in. Concrete mixing plants in the case of contracts Nos. 32, 33 and 34 are located adjacent to the contractors' storage platforms on the District railway. Narrow-gauge tracks are built from the mixing plants along the aqueduct trench on the spoil bank left by the dragline for a distance of about one-half mile in each direction. Concrete is conveyed to the work by small dump cars drawn by gasoline-driven locomotives. Chutes deliver concrete from the cars on the construction track to the forms in the trench.

**Progress of Work.**—The progress accomplished during the year 1915 has fallen a little behind that anticipated. Eighteen per cent. of completed aqueduct was required and about fourteen per cent. was completed. This failure to make the necessary progress was mainly due to a very wet season and to delay in getting a proper start. The schedule of future progress required by contract is as follows: 50 per cent. up to December 1st, 1916; 85 per cent. up to December 1st, 1917; 100 per cent. up to September 1st, 1918.

**Engineering Organization.**—For carrying out the engineering direction of the aqueduct, five division headquarters' camps, one for each contract, have been established, each with a division engineer in charge, having under him, an assistant who is responsible for the lines and grades, an office man to look after field records and sketches, an instrument party, a stenographer and senior and junior inspectors. These inspectors in order that they may be present at all times on the work, live in tents at each point where work is in progress.

Each division engineer is provided with a light gasoline-operated track speeder, and each party with a large speeder capable of carrying six men with instruments, so that even on contract 30, which extends over a distance of twenty miles, the work is handled with expedition, and by means of a comparatively small staff of men.

The active co-operation and support given to the engineering project by the commissioners, Messrs. S. H. Reynolds, M.Can.Soc.C.E., and James H. Ashdown, has been a great factor in the successful prosecution of the work to date, and much of the success is due their untiring energy and business acumen. The engineering work is under the direction of Mr. James H. Fuertes, M.Am.Soc.C.E., of New York, consulting engineer, and W. G. Chace, chief engineer. M. V. Sauer is assistant chief engineer in charge of designs, and next in authority to Mr. Chace. The division engineers in charge of construction under the different contracts are: C. J. Bruce, contract 30; R. T. Sailman, A.M.Can.Soc.C.E., contract 31; G. F. Richan, A.M.Can.Soc.C.E., contract 32; W. R. Davis, contract 33; A. C. D. Blanchard, M.Can.Soc. C.E., contract 34. Messrs. D. L. McLean and F. G. Haven, both A.M.Can.Soc.C.E., are assistants to the chief engineer, the former having charge of all studies relating to concrete aggregates and cement tests. These engineers have all been employed by the District since the beginning of the work, and carried out the original surveys, construction of the telephone line and final location of the aqueduct.

## THE USE OF STEEL CONDUCTORS FOR TRANSMISSION LINES.*

By H. B. Dwight.

ALTHOUGH the tests to determine the electrical properties of steel wires and cables are incomplete, they nevertheless show some attractive possibilities from both commercial and engineering points of view for the use of steel instead of copper for certain classes of work. Already small-sized steel conductors have been used with success in America, and this practice may be extended by a knowledge of the characteristics of large steel cable.

The resistance of an iron or steel conductor is considerably greater for alternating current than for direct current. This is partly due to the skin effect—that is, the crowding of the alternating current to the outside part of the conductor—and by hysteresis or iron losses caused by the alternating magnetic flux in the steel.

Although high-grade steel wire proved to be the best conductor for direct current, on account of its higher permeability to magnetism it has a higher resistance to alternating current than a low-grade, less expensive conductor. Thus the cheaper grade was found to be more suitable for alternating-current work. This conclusion is also stated in a recent Bulletin, No. 252, of the Bureau of Standards, Washington, D.C. The Bureau tests show that at commercial frequencies the increase of resistance is approximately proportional to the frequency. It is of interest to note that increasing the number of wires in a cable decreases the reactance, while increasing the size of the wires increases the reactance.

Another point brought out by the test is that a large part of the magnetization is caused by the spiraling of the wires in the cable. If the spiraling of the different groups of wires is properly reversed, the increase of effective resistance can be reduced as much as one-half. Thus, if the spiraling of one layer of wire is clockwise, the next should be counterclockwise.

The effective resistance and reactance of a steel conductor increases as the current increases. This, however, only continues to a certain point where the effective resistance begins to decrease again. In both cases, especially in large cables, the decrease is very slow and the resistance is maintained approximately at its maximum value for large value of current. This property should prove useful in transmission-line work, for the conductor will have a low impedance to the normal load current, but will have about twice as much impedance to the current flowing in case of a short-circuit. The impedance will also be large in high-frequency surges, caused by switching or lightning. It may prove more economical in certain cases to protect a line against short-circuits and surges by using steel conductors than by installing current-limiting reactors or by increasing the reactance of the transformers.

This property may also be used in the case of feeders of direct-current interurban railways. If the feeder be a steel cable, it will have low resistance to direct current but high resistance to alternating current. It will, therefore, tend to dampen out the suddenness of short-circuits and lightning surges, which cause synchronous machines to flash over.

*Abstract of a paper read before the tenth annual convention of the Association of Iron and Steel Electrical Engineers in joint session with the American Institute of Electrical Engineers, Chicago, Ill.

If the feeders are made of steel, and especially if the stranding be coarse, the required protection will be still more complete. Steel conductors would probably be economical only where it is allowable to use bare cable, as the increased amount of insulating covering required for large-sized steel cables, compared with copper ones of the same conductivity, would greatly increase the cost of the former.

The higher conductivity of steel for direct current than for alternating current makes the use of bare-steel cables for direct-current feeders more economical than for alternating current. A steel cable has about eight times as much resistance to direct current as a copper cable of the same size and seven times as much resistance as a copper cable of the same weight, since copper is more dense than steel. Galvanized steel cable usually costs less than one-seventh as much per pound as copper cables, and so should be more economical, other things being equal.

A large 60-cycle power system in the State of Washington makes use of a considerable quantity of No. 8 iron wire for short tap-offs and lightly-loaded branch lines on 6,600-volt circuits without serious trouble resulting from voltage drop. The iron wire is far cheaper than No. 6 copper. One line built by the company is an example, showing that it may be profitable to supply a surprisingly small load at a distance of several miles. This line is 10 miles long and was originally built with No. 8 copper-clad steel to supply a 50-h.p. load at 6,600 volts. The line afterward carried 110 h.p. for some time and was later changed to No. 6 copper in order to have a capacity for a still greater load.

An example from Minnesota shows the use of a somewhat larger steel conductor. This line operates at 40,000 volts, 60 cycles, and is 20 miles long. No. 4 galvanized steel cable made of three wires is used. The load is about 300 kv.-a.

An example of an 11,000-volt line designed for 75 kv.-a., the smallest size of copper conductor that can be used is No. 6 B. and S., and would cost $2,600. A 25,000-circ.-mil steel conductor can be used and will cost only $220. The copper conductor in this case has a capacity of 750 kv.-a., but on account of mechanical strength a smaller conductor cannot be used.

Besides being cheaper than a copper cable for small branch lines, the steel cable has the advantage of being mechanically stronger and less liable to be burned through by arcs. The steel is, therefore, of greater reliability at times of wind storms and at times of electrical breakdowns or trouble. Steel cables are subject to the disadvantage that their useful life is shorter than that of copper cables, especially near the seashore, where galvanized steel is more quickly oxidized.

The price per pound of copper cable may be assumed as being ten times that of galvanized-steel cable. This ratio is a usual one, being approximately true for times when prices of metals are low as well as times when prices are high. From the data available it seems probable, considering a heavy transmission line complete with towers and insulators where an extra weight of steel conductor would be troublesome, the cost will be approximately the same for the two materials. However, there are many cases where extra strength and size of steel cables are advantageous, and so at present the chief attention should be given to the classes of work where steel can show other advantages than merely low cost on a basis of carrying capacity for alternating-current power.

On very high voltage transmission lines, where the corona limits determine the size of conductors, the steel conductors have an opening, for use on branch lines supplying a few thousand kv.-a. on networks of 100,000 volts and higher.

In conclusion, it has been shown that large steel cable, if properly manufactured, can be used for carrying alternating current. It appears that the chief opportunity for the use of steel conductors is on branch lines where the size of copper required merely for the electrical loads would be too small to use. However, in all cases steel conductors will be nearly as cheap as copper ones, if not cheaper, and the use of steel will always increase the reliability of the transmission system.

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## HYDRO-ELECTRIC RADIAL RAILWAYS FOR THE NIAGARA PENINSULA.

A MEETING of delegates of the Ontario Hydro-Electric Railway Association was held at Hamilton recently, when plans of the proposed railway to be built by the Ontario Hydro-Electric Power Commission, between Toronto and Niagara Falls were explained and discussed. The portion of this line between Toronto and Port Credit has already been dealt with by the various municipalities concerned, the second section, that between Port Credit and St. Catharines, being one chiefly under discussion.

F. A. Gaby, chief engineer of the Commission, in explaining, stated that the route it was proposed to follow through Hamilton was that adopted by the Canadian Northern Railway, and it was probable that the C.N.R. right-of-way would be taken over and the Hamilton station located on James Street, near Murray Street. The line, when completed, would be available for other railway companies on terms being arranged. It was estimated that the right-of-way would cost $2,000,000 and the construction, so far as Hamilton was concerned, $2,250,000, and stations and terminals about $500,000. The line would run from Port Credit, where a junction would be made with the proposed Toronto-London line, thence to Clarkson, through the centre of Oakville, then south of the G.T.R. and parallel with the Hamilton Radial Railway, through Burlington. From the last-mentioned point two surveys had been made, one on the north and one on the south of the Plains Road. The line would cross the G.T.R. overhead and proceed along the proposed Canadian Northern Railway route, and thence to Stoney Creek, Winona, Vineland, Grimsby, Beamsville and St. Catharines. It was intended to use 80-lb. steel, and the whole equipment would be of the highest class, with rolling stock similar to that used on the London and Port Stanley Railway. Mr. Gaby also stated that four lines had been surveyed from St. Catharines to Niagara Falls, and the Commission was of opinion that two lines would be required, one to go via Port Robinson and one by a more direct route.

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The Venezuelan Government has decided to build a highway across the republic that will be 683 miles long.

A new type of ship has arrived at Christiana, Norway, from the shipyards of Christianiafjord. The ship, which resembles a huge barge, is constructed entirely of concrete, except for the ribs, which are steel, and is the first stone vessel ever floated. It is said the hull will resist damage better than steel or wood, and that the ship is therefore safer.

## REPORT ON WATER SUPPLY FOR HAMILTON.

AT the joint request of the Board of Control and sub-committee of the works committee, Mr. James Milne, mechanical and electrical engineer, City Hall, Toronto, has prepared a report covering suggested extensions of the waterworks of Hamilton. The following extracts are taken from his interim report:—

The water supply for a large city is unlike any other public undertaking. It must be of ample quantity and continuous. When the power for street railway purposes fails, the public are inconvenienced, but can resort to walking. When the electric lighting fails, the public can resort to gas, coal oil lamps and candles. When the water fails, however, there is nothing they can resort to; and besides endangering the public health by putting all sanitary arrangements out of action, such a failure, should a serious fire arise, would become nothing short of a calamity.

Pumping stations for waterworks should be self-contained; that is to say, power for operating the pumps should be absolutely under the city's control and independent of any outside source. Experience has shown that where a waterworks pumping plant is dependent upon an outside source for power, and the plant and accessories are not under the absolute and immediate control of the owners, continuity of service cannot be guaranteed. It may also be noted that electric power for pumping purposes in first-class plants has not been shown to be less costly than steam. The only point, therefore, in favor of electrically operated pumps is their low initial cost.

Turning to the consideration of the proposal made to you by the Dominion Power & Transmission Company, in their letter of the 3rd of August, 1916, the adoption of this proposal would mean that, after going to a considerable expense for plant and transmission lines, you would still be purchasing power at a high cost from an outside source. Bearing in mind the indispensable condition of continuity of service, together with the consequent necessity of having the power plant under your own control, and the further important fact, that electric power for pumping purposes is not cheaper than steam, I do not consider it would be to your advantage to accept the proposal of the Dominion Power & Transmission Company. If the company had the necessary power available, and, without involving the city in a large expenditure for generator, transmission lines, etc., would agree to furnish an auxiliary service (to be used in case of the failure of Hydro power) at a reasonable cost, in a manner similar to which the Toronto Power Company furnish an auxiliary service to the Toronto waterworks, such an arrangement might be of advantage to you, until such time as you have a plant of your own, capable of furnishing the city's full requirements.

Coming now to the consideration of the extensions required to your pumping station, I may first remark that your reservoirs are of such small capacity that they have little or no bearing on the required capacity of the pumping station; and to increase the capacity of the reservoirs is at present out of the question. For practical purposes, therefore, and leaving out all academic discussion on reservoirs, which, while useful, are not absolutely essential; the pumping station should be so designed as to furnish, without interruption, the maximum demand and have, in addition, at least one spare pumping unit. Your average daily pumpage for last July was 14,500,000 Imperial gallons, which is an increase of 40 per cent. over the average daily consumption for the year 1915, and the maximum for any one day in July, 1916, was 16,677,240 Imperial gallons. The fire underwriters require that the system shall be capable of maintaining twenty-five standard fire streams for a period of ten hours, in addition to satisfying the normal demand. This quantity for fire purposes is equivalent to a rate of 7,500,000 gallons every 24 hours.

It is obvious that your pumping capacity is lamentably short of actual requirements, and in order to properly safeguard the city, I recommend that one steam pumping unit, of not less than 15,000,000 gallons capacity, together with the necessary boilers and appurtenances, including buildings and chimney, be installed with as little delay as possible. The building should be of such size that another unit, together with the necessary boilers, can be installed later on.

There are three types of pumping units which may be considered, *viz.*:—

1. High duty.

2. Turbine-driven centrifugal pumps (where a turbine runs at one speed and the pump runs at a much lower speed, this reduction being brought about by practically noiseless gearing).

3. Centrifugal pumps driven direct by triple expansion vertical engines.

The high duty unit is the most expensive and occupies the most space: It is also, however, the most economical in fuel consumption. The turbine-driven centrifugal unit is the cheapest and occupies the least space, and is next in economy to the high duty engine. The centrifugal pump, driven by triple expansion vertical engine, is about 15 per cent. less economical than the turbine-driven unit. Types Nos. 2 and 3 will show, however, a much greater economy than any of the steam pumping units you already have in operation.

Assuming that new buildings have to be erected for the pumps and boilers, and of such size that another pump and another set of boilers can be installed later on, I give below an estimate of the cost of each, *viz.*:—

| | High Duty | Turb.-Driven Pump | High Speed Vertical Eng.-Driven Pump |
|---|---|---|---|
| Engine | $125,000 | $ 55,000 | $ 65,000 |
| Foundations | 4,500 | 1,500 | 2,000 |
| Discharge main and valves (to present system) | 5,000 | 5,000 | 5,000 |
| 4 water tube boilers, 3 of which are capable of running the units, together with steam connections | 30,000 | 30,000 | 30,000 |
| Buildings | 60,000 | 30,000 | 30,000 |
| Contingencies | 5,000 | 3,000 | 3,000 |
| 5 per cent., engineering | 12,085 | 6,580 | 7,105 |
| | $241,585 | $131,080 | $142,105 |

Following up this interim report, which was made August 22nd, Mr. Milne reported under date of September 7th to the Board of Control, making the following suggestions:—

The new engine room would be an extension of the present Osborne Kelly engine room, and foundations could be laid for a building capable of accommodating three large pumping units. It would be at your option as to whether the building, approximately 115 feet in length, should now be built.

Pump No. 3 would be the first installed.

The boiler room, when completed, will contain 14 water tube boilers, but only four will be required for one pumping unit, *viz.*, boilers 7, 8, 9 and 10.

As the plant is extended, the five return tubular boilers for the Osborne Kelly pumps will be replaced by water tube boilers.

A new 6-foot conduit from the basin will be required, same to discharge into a suction well, from which the new pumping units will take their supply.

From this suction well, a 48-inch connection shall be made to your present well.

The new pumping units will discharge into a 72-inch steel header, from which five 36-inch discharge mains can be taken: Discharge main A to be connected to your present header; discharge main B to be connected to the 36-inch main running from your present header; discharge main C to run to city and improve present conditions; branches D and E to be blank flanged for future extensions.

The cost of the 6-foot conduit from the basin to the suction well, together with well and connection to your present well, will be about $38,500; this conduit to be partly steel and partly concrete.

The discharge connection from pump No. 3 to, and including header, together with mains A and B, will cost approximately $27,500.

It is, no doubt, your intention to continue the use of the present electric pumps, even after the steam units are installed; and, such being the case, I could not advise you to install coal bunkers, nor mechanical stokers. These need only be considered if the steam pumping units were to operate continuously.

Provision, however, for the bunkers should be made in designing the building, so that they can be installed in the future, should operating conditions warrant.

A new pumping main will most assuredly have to be installed in the immediate future, but I am not prepared to say at present where this should be run to, as additional information will have to be given me as to pressures, etc., throughout the city.

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Japan obtains more than 2,000,000 h.p. from its streams by nearly 400 hydro-electric plants.

The Chinese Government has concluded an agreement with the Siems-Carey Co., of St. Paul, Minn., for the construction of more than 2,000 miles of railways. The probable cost of this work will be over $100,000,000 and construction will begin immediately. This is the largest single railway contract ever signed by China.

The railroads of the United States used 128,200,000 net tons of coal in 1915, or 24 per cent. of the total output. The bituminous mines furnished 122,000,000 tons, or 28 per cent. of their production, and the Pennsylvania anthracite region 6,200,000 tons, or 7 per cent. its production. The roads in the eastern district, north of Potomac and Ohio rivers and east of Chicago, Peoria and St. Louis, used 56,500,000 tons of bituminous coal and 6,200,000 tons of anthracite, a total of 62,700,000 tons. The roads of the southern district, south Potomac and Ohio Rivers, and east of the Mississippi, used 22,000,000 tons of bituminous coal, and the western roads consumed 43,500,000 tons.

During the year ending June 30, 1916, Canada exported to the United States 52,742 tons nickel-copper matte containing 64,622,286 pounds nickel, and worth about $16,000,000. The value given in Government records is $8,596,921. During the same period Canada exported a large quantity of nickel-copper matte to Wales. Figures are not yet available, but the nickel contents of matte shipped to both countries will total about 76,000,000 lbs., worth about $19,000,000. In addition, the matte contained copper worth in the matte probably $5,000,000. In other words, there was shipped during the year ended June 30, 1916, from the smelters in Ontario, matte worth about $24,000,000. The metals in the matte when refined would be worth about $40,000,000.

## IMPROVEMENTS ON NIAGARA FALLS PARK AND RIVER RAILWAY.

J. C. Royce and H. W. Middlemist, engineers for the Ontario Railway and Municipal Board, have presented the following report on the improvements which were made recently on the Niagara Falls Park and River Railway. On August 19th, accompanied by the chairman of the board, we conducted a test on the Queenston hill, in order to ascertain the efficiency of the new safety switch and the effect on the speed of the car produced by the change of grade and radius of curve. A car was provided by the company, whose officials were present and witnessed the test.

A test was first made of the safety switch by starting the car freely without trolley connection from the curve at Dumfries Street, 200 feet up the grade, and allowing it to accelerate to the end of the switch. The car was then taken to Dumfries Street to a point about half-way between the two curves there and started freely and allowed to attain a speed it would likely do in case of accident, and was brought to a stop at the end of the safety switch. A test was then conducted in order to ascertain the acceleration of the car from the safety switch to the end of the lower curve near the river, the radius of which had been increased to 145°, and the grade reduced to 4.2 per cent. The car started by gravity from the switch and passed satisfactorily around the curve without the application of the brakes.

A further test was made of the braking power of the four motors which are now installed in the cars in accordance with the board's order. The trolley was taken off the wire and the car allowed to run free, and when it attained considerable speed the lever on the controller was thrown into reverse position and the car was brought successfully to a standstill by the resistance of the motors only. Another test was made to ascertain the acceleration which the car would attain on the curve itself, and this was found to be comparatively small on account of the curve resistance.

We consider these tests satisfactory, in so far as they show the efficiency of the safety switch, and that if a car should run freely down the grade from the safety switch it should pass around the curve at the river at a safe speed, unless power is applied by the motorman voluntarily, in which case no precautions taken by the board will avail. We have taken into consideration the use of a dead trolley wire between the switch and the end of the curve as a precaution against the motorman using current and thereby attaining speed beyond the safety limit on the curve. We have decided, however, not to recommend this, as it is advantageous to have current available at all times while passing down grade, not only for operating the air-brake and lighting system, but to enable the motorman to reverse his car, which would be advantageous in case of emergency.

We also called the superintendent's attention to an irregularity in the curve on the safety switch, and he promised to rectify this. We would recommend that the spring frog at the safety switch be kept greased, and have pointed this out to the superintendent, who has promised to see to it.

In reference to the improvements which have been made on the N.F.P. and R. Ry. to secure greater safety, it may be stated that the original construction of the portion of the line from Queenston wharf to Brock's monument required similar methods to those used by steam railways in mountainous countries. The distance on a straight line from the top of the hill to the wharf is 2,650 feet. The difference in elevation is 293.8 feet. To descend this hill, without an excessive gradient, the line had to be lengthened. This was accomplished by constructing along its face for 2,100 feet westerly, where it turned in an easterly direction, still on a descending grade. The length of track actually constructed between the named points was 7,500 feet. A section of track where the gradient was 5.7 per cent., at the foot of which was a curve having a radius of 115 feet, has been raised several feet at the low place recently, and the alignment has been changed so that the curve radius is now 145 feet. A new safety switch has also been installed.

## ELECTROLYSIS IN UNDERGROUND PIPES.

Some important considerations relating to the mitigation of the electrolytic corrosion of underground pipes by stray currents are embodied in a report of the United States Bureau of Standards.

It is found that paints, dips, wrappings, etc., are not of much avail in themselves, although useful in a secondary way. Even insulating points offer but an imperfect guard. The Dressem coupling is commonly used in gas mains. A sleeve rests with rubber packing on the two pipe ends, and is sub-divided by rubber insulations. Through the use of this coupling high insulation resistances have decreased to a few ohms. In leadite joints the decrease occurred in a very short time. In this case the leadite, which is poured like lead, contains sulphur, resulting in sulphuric acid when the ground is wet.

Wood stave joints, as used by the Pennsylvania Water Company, do well in an area where jointings are few, and appear to be preferable to wood stavings wrapped in asphalted spiral steel tape.

The Metropolitan Water Board, Boston, has recourse to a plain sort of joint, consisting of planed and shaped overlapping sections of white pinewood built up to form a ½-in. lining, encased in paraffin impregnated canvas. The ring thus formed and driven in prevents the pipe ends coming into contact, and stops leaks up to a pressure of about 75 lbs. A higher pressure is overcome by closing the pores of the wood in a bath of red lead. The spigot end of the pipe may be banded with iron.

Another type is a cement joint with a packing of rubber or fibre between the ends of the pipes. After a hempen ring is driven in, cement is added, and then another ring of hemp binds the joint. The report recommends that tarred paper or a coating of pitch may be used on the exterior. Another point which compels attention is that of the danger to electric pipe drainage system by negative boosters. The bureau opposed the system of pipe drainage in a complicated area.

A warning is issued against uninsulated negative feeders accompanied by the following suggestions: (1) Limit the actual potential drops on the earth or on pipe network; (2) limit the over-all voltage drop to 2 or 4 volts, and the gradients to 0.3 or 0.4 volt per 1,000 feet; (3) install permanent potential wires to determine drop period values. The bureau deprecates metallic connection between underground metallic structures and the track, and recommends inter-connection of intersecting or parallel tracks as well as good bonding and cross-bonding.

## CANADIAN TERMINAL HARBORS ON THE GREAT LAKES.

(Continued from page 292.)

minal elevators? Why nineteen terminal elevators served by only one railway Why flour mills served by only one railway? Why the Harvesting Company's assembling plant served by only one railway? Who stands the economic loss due to lack of co-operation? Who stands the loss due to duplication?

The "Head of the Lakes" in Canada may continue to hold its situation without a rival. A combination by the three railway companies, resulting in a large joint railway, elevator and harbor terminal, for the economical and speedy transfer of grain from rail to vessels for shipment to storage elevators at eastern lake ports, is a possibility which should be made unnecessary of consideration.

**The Upper Lakes Service.**—From the Head of the Lakes, further transportation eastward brings in the all-important question of whether the route will continue through Canadian ports or whether the business will be diverted to the United States. The owner of the grain is not expected to be controlled by sentiment. The route by which he receives best and surest profits is chosen.

National or State policy is another matter. Actual economy of transport so as to increase the price to the producer, or cheapen it to the consumer, is a point well taken with statesmen. Much more is the tolls on commerce of interest to a people and her legislators. All along the line every station, every town, as well as every port or terminal reaps the reward.

Therefore, the chief point to Canada to increase the business through the ports, is the effort to make such a route as will compete with the main Buffalo-New York route. It were well worth while, even at a sacrifice. The great State of New York is setting the example.

Can engineers design and construct a route, and operators achieve costs to meet the competition? This is the most important commercial question in Canada to-day.

**Port Colborne.**—Port Colborne, from a point of distance, is equal to Buffalo. From this port to Montreal, by the St. Lawrence Canal System, the present water route, is far and away ahead of the nearly completed barge canal to New York. Port Colborne, however, for winter business, is out of it.

Port Colborne harbor is the Lake Erie entrance to the present 2,500-ton Welland Canal. The necessary entrance to the canal made an excellent ready-made harbor with the addition of a landing quay, an elevator and a railway terminal.

From Port Colborne to an Atlantic Ocean port the distance, by 2,500-ton vessel, is only 369 miles.

Buffalo to New York by the 1,500-ton barge canal, is 497 miles.

For canal navigation, the seasons being equal by either route, Port Colborne to Montreal has much the best of it.

But there the advantage ends. Port Colborne has one modern transfer elevator, and a very excellent one, belonging to the Government of Canada. The storage capacity is 2,000,000 bushels. It can unload grain from the largest sized lake vessels and has every facility for despatch. There is also the Maple Leaf Milling Co.'s elevator, with a capacity of 1,500,000 bushels.

Buffalo, on the other hand, has sixteen elevators, with a capacity of some 18,000,000 bushels. At the close of navigation, grain stored in elevator or vessel at Buffalo has the winter market advantage and the cheap rail route to New York. Anything stored in Port Colborne is at a competitive disadvantage.

The Welland Canal from Lake Erie to Lake Ontario is, however, in process of enlargement. A year or so after the completion of the 1,500-ton New York barge canal, the New Welland will pass the 10,000-ton lake vessel, which then will have a clear run to Prescott.

Prescott is only 119 miles from Montreal. Lighterage from Prescott to ocean vessels in Montreal harbor will then be almost as cheap as from the New York State Canal terminals to the ship, and Prescott elevators will be within order distance when vessels require grain. For grain at Prescott, no Atlantic port can compete with Montreal in summer, and grain in a large storage elevator at Prescott will also be in an excellent position for shipment in winter via St. John or Halifax.

The Georgian Bay Canal project or the completion of the ship canal between Prescott and Montreal, is a subject in itself.

**Lake and Rail.**—John R. Booth, an Ottawa lumberman, was the first to appreciate, and willing to back "lake and rail," a Canadian economic grain route. He built a railroad from Depot Harbor, through Ottawa to Coteau, near Montreal, and constructed elevators and freight sheds at the terminals. His route, now owned and operated by the Grand Trunk Railway System, is the shortest both by lake and by rail, but the railway has "grades." The Depot Harbor route runs over the height of land and the Grand Trunk Railway has completed up another line, via the Peterborough watershed from Midland to Montreal, as a grain route.

At Midland the Grand Trunk Railway has developed its railway lake terminal. The natural advantages for a harbor here are many as compared with an exposed lake situation like Buffalo.

**Midland Harbor (Tiffin).**—Midland harbor is situated on Midland Bay, the most eastern indentation of Georgian Bay. The town, including the terminals, has a population of about 5,000. The only railroad serving Midland is the Grand Trunk.

The town has extensive lumber mills, coal docks, freight sheds, steel works and other prosperous industries. The original harbor is close to the town in the southern arm of the bay, while the new grain and warehouse terminals are situated on the eastern arm. The shelter throughout the harbor is excellent and loading and discharging are carried on under most favorable conditions. As a winter quarters for vessels, both loaded and otherwise, the harbor offers special attractions as to safety and for the shipment of grain.

The entrance to the harbor is favorable from a navigation point of view. The depth of water is ample and there are no difficulties of a bar as in many harbors on the Great Lakes.

The new railway terminals are situated at Tiffin, a suburb of the town of Midland. These consist of extensive sidings, modern docks for deep water berths, warehouses and grain elevators.

The elevator facilities at Midland are as follows: Midland Elevator Co.'s elevator, capacity, 1,000,000 bushels; wooden structure, iron sheeted; capacity from vessel, 10,000 bushels per hour; depth of water, 22 feet. Aberdeen elevator, capacity, 1,000,000 bushels; iron structure; capacity from vessel, 10,000 bushels per hour; depth of water, 25 feet. Grand Trunk Railway elevator, capacity, 2,400,000 bushels; concrete structure; capacity from vessel, by two travelling marine legs, 24,000 bushels per hour; depth of water, 25 feet.

For future extensions the plans call for several additional units. During the twelve months ending July 31st, 1916, 29,500,000 bushels of grain passed through this port.

**Port McNicoll.**—Port McNicoll harbor is also on the most easterly point of the Georgian Bay. The harbor was formerly called Victoria Harbor. The distance from Midland harbor terminals is about 2¾ miles. This is the Canadian Pacific Railway grain terminal on the Georgian Bay, connecting with their railway grain route to Montreal. The company has extensive machine shops and a large round house at this point.

The population of Port McNicoll, together with Victoria Harbor, is about 2,000.

The Canadian Pacific Railway Company has built at this place deep-water wharves for about eleven vessels and also a large freight shed 700 feet long and a flour shed 800 feet long. The type of construction of the wharves varies considerably. The portion in front of the elevator is of solid concrete; another portion is of concrete superstructure on concrete cribs, and a further portion of concrete superstructure on timber cribs.

The scheme proposed by the Canadian Pacific Railway Company for this grain terminal is a very complete and comprehensive one. It is designed as a lake terminal of the most permanent and up-to-date type and every care was taken to plan the work to suit this end and to take every advantage of the natural features of the site.

The important pier, taking in Maple Island, is designed to be 3,000 feet long and 650 feet wide. The northwest face for the whole length has been completed and the first two units of the elevator with two marine legs, power house and tracks, sheds and complete railway terminals built and put into operation.

The scheme includes four additional units of 2,000,000 bushels capacity each, and the completion of the southeast face of the pier.

For an elevator system, economical, quick handling, large storage capacity, splendid railway terminals, permanent, and capacity for future extensions, port authorities would do well to watch this important development.

During the twelve months ending July 31st, 1916, 34,300,000 bushels of grain passed through this port.

Adjoining the grain pier is a basin 600 feet wide and 25 feet deep. The bulkhead wharf on the opposite side of the basin is 3,500 feet long. On this, besides the railway terminals, flour shed and freight shed, there is a passenger station for connecting the upper lake service with the Canadian Pacific Railway.

Midland Bay, on which the harbors of Midland and Port McNicoll are situated, has an excellent reputation as to weather, fogs and ice conditions. They have never known ice shoves in the harbors, and dredging, after excavation has been done, is not required.

These two harbors, situated on the water-front, almost adjoining, are very high-class examples of lake terminals. It is expected that large storage additions will be added to the elevators with the idea of shipping as much of the summer's crop as possible across the lake before the navigation season is closed for the winter. The elevators are the most perfect examples of design and construction for efficient working, cheap insurance and careful handling.

The regular business capacity of the elevators at each of the railway terminals is receiving from vessels, storing, and shipping by railway cars at the rate of from 300,000 to 400,000 bushels per day.

**Lake Ports to Ocean Ports.**—During the open season of navigation, from 1st May to end of November, the grain is shipped by Canadian Pacific Railway to Montreal and by Grand Trunk Railway, partially to Montreal and partially to Portland.

There is a great advantage in grain storage at Georgian Bay locations. The distance is from 360 to 400 miles from Montreal, so that regular shipments may be made at lake elevators as required at Montreal. The two systems at Montreal and the Georgian Bay regularly take care of each other's business.

The railway routes from Georgian Bay ports to Midland and Port McNicoll to Montreal, are excellent for solid, heavy grain trains. These ports also furnish winter business for the two roads in question for their winter ports at Portland, Maine, and St. John, N.B.

The Grand Trunk Railway also have a grain route via Depot Harbor, Ottawa and Montreal. This route is the shortest of all lake and rail routes. The harbor at Parry Sound is excellent, but as the railway runs over the height of land, the grades are not so favorable for heavy grain loads.

**Georgian Bay Ports.**—The almost adjoining port terminals on the Georgian Bay, two units giving every known modern type of perfection, are open to the same criticism of port authorities as the twin ports at the Head of the Lakes.

The two large modern elevators in Montreal harbor, Nos. 1 and 2, working as one unit, are showing economic advantages worthy of note, but probably the best features are: the one organization, the one operating railway terminal and the combination of the two stores capable of being drawn upon to complete orders as required. The result is despatch and economy and general satisfaction.

Port authorities may well study the question, with a view of some remedy, for the general non-economic unit system of railway port terminals.

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## CANADIAN SOCIETY OF CIVIL ENGINEERS.

A meeting of the Society was held on October 5th, when W. G. Chace, M.Can.Soc.C.E., and M. V. Sauer, M.Can.Soc.C.E., read a paper on "The Aqueduct for the Greater Winnipeg Water District." Accompanying the paper was a supplement entitled "Studies Regarding Concrete Mixers Employed in the Work," by W. G. Chace and D. L. McLean, A.M.Can.Soc.C.E.

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## CANADIAN SOCIETY OF CIVIL ENGINEERS, MANITOBA BRANCH.

The regular monthly meeting of the General Section was held in the University of Manitoba, Broadway, Winnipeg, on Thursday, October 5th, at 8.15 p.m., when Professor R. C. Wallace, of the University of Manitoba, read a paper on "Mining Developments in Manitoba."

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A bridge 5.5 miles long and costing $22,000,000 is planned to be built by San Francisco across the bay to Oakland. It will be a double-decker, carrying four railway tracks and three roadways. This will be the most costly bridge in the world.

# Editorial

## APPOINTMENT OF ALIEN ENGINEERS.

Announcement was made last week of the appointment of Morris Knowles, of Pittsburgh, as consulting engineer to the Essex Public Utilities Commission,—a commission formed to devise a joint water and sewerage scheme for Windsor, Walkerville, Ojibway, Ford City, Sandwich and Sandwich West. This is a most flagrant example of the way in which competent Canadian engineers are ignored and aliens appointed to lucrative positions that could well be kept at home.

There seems to be no excuse for such an appointment. There are any number of consulting engineers in Canada who are thoroughly qualified to plan sewer systems, sewage treatments or waterworks. The sum of $5,000 is allotted by the Act creating the above-mentioned commission, for the purpose of studying and reporting upon the sanitary problems of the district affected. Presumably Mr. Knowles gets the $5,000. He is most likely a good engineer and will undoubtedly fully earn that fee—we understand that he is director of the sanitary engineering department of the University of Pittsburgh—but, in the present state of affairs especially, when Canadian engineers have been hit so hard by war conditions and yet have done so much toward the successful prosecution of the war, should not this $5,000 be kept at home in common justice to our own citizens?

How different such a case as this is from the appointment of Prof. Swain as consulting engineer to the Railway Board of Inquiry! What a pity that the council of the Canadian Society of Civil Engineers did not select such a clear-cut case as this as the one upon which to base its protest against the employment of alien engineers.

It may be argued that Swain's appointment was by the Dominion Government and that such appointments as the Knowles case are by municipalities. To this we would reply that there have been other cases of appointments by the Dominion Government that were far less justified and that would have been better material for such a protest. Moreover, the Society's grievance does not lie altogether with the Dominion Government. Are not ten alien engineers appointed by municipalities in Canada to every one appointed by the Dominion Government?

It will be recalled that the editorial in *The Canadian Engineer* of September 28th upon this same subject did not endorse the appointment of Swain personally. Swain, himself, may or may not be the best man who could have been obtained. The points that we made were simply these:—

(1) That occasionally outside viewpoints or specialized services are desirable, and therefore some alien appointments are justified.

(2) That the position of consulting engineer to Canada's Railway Board of Inquiry is one of the occasional instances where the selection of an outside man may be the wisest appointment.

(3) That in regard to the principle of alien appointments in general *The Canadian Engineer* agrees most heartily with the spirit of the council's protest, but it disagrees with the selection of the Swain appointment as "Exhibit A" in the evidence, and it disagrees with many of the arguments quoted in the council's circular regarding the Swain appointment and the propriety of appointing "any experienced engineer."

One paragraph in our editorial of September 28th seems to have been misunderstood by at least one reader. We refer to the sentence, "Yet, in this case, the appointment of Prof. Swain seems more commendable than the appointment to the chair of the Railway Board of Inquiry of a man who controls important railroad interests in Canada, and who has affiliations and competitions that cannot but unconsciously color his viewpoint."

We were not "commending the appointment of Swain in preference to some mythical person unnamed." What was meant was that the commission's appointment of Swain was certainly more commendable than the government's appointment of A. H. Smith as chairman of the commission. Mr. Smith controls important railroad interests in Canada. He has affiliations and competitions that are most likely to unconsciously color his viewpoint.

Why the chairman of the board should be an American railway president who is amongst the most formidable competitors for the transportation of Canadian products to the American seaboard, passes our Canadian comprehension. The New York Central controls the Michigan Central. Sir Robert Borden should earnestly study a railroad map of North America and note what important links in the New York Central System are the Michigan Central lines in Canada, and how a nationalization or liquidation of any or all Canadian railways might affect New York Central interests.

The appointment of an American engineer to the Railway Board of Inquiry is justifiable. But the appointment of that American engineer to work under the direction of an American chairman—particularly Mr. Smith—is another matter. Mr. Smith should resign from the board, or at least from its chairmanship. Sir Henry Drayton or Sir George Paish should be the chairman of Canada's Railway Board of Inquiry, or the people will not have abiding faith in whatever report the board may make.

## PUBLIC UTILITIES AND PUBLIC OPINION.

Much has been written and many addresses have been delivered concerning what should and what should not be the relationship between public service corporations and public opinion. Public utilities in Canada, by which is meant such corporations as cater to a community, or a group of communities, have been subject, more or less, to the usual antagonism and misunderstanding that is the common lot of such enterprises.

Slowly, but none the less surely, however, a better understanding of the attitude which these two sides should assume, one toward the other, is gaining ground. In more recent years those in charge of public utility corporations, at least the most aggressive of them, are realizing as they never did before that their very existence depends upon the support of public opinion, and that no permanent success can be attained without a real effort to "cuddle up to John Smith." After all, does it not all hinge upon the company's simply taking into its confidence the public, without whom its franchise is worth-less? It is a partnership in the real sense of the word. This means that there must be no dodging the issue. So far as the private corporation is concerned, frankness is absolutely essential if the public is to keep faith with it.

## PERSONAL.

RALPH SCOTT, formerly of the Dome mine staff, is now manager of the feldspar mine at Verona, Ont.

W. G. ROSS, chairman of the Montreal harbor commissioners, has been elected president of the American Association of Port Authorities.

W. ROBERTS DEVENISH, A.M.Can.Soc.C.E., has been appointed superintendent, District 3, Intercolonial Railway, Moncton, N.B.

Lieut.-Col. G. C. ROYCE, general manager, Toronto Suburban Railway, has been appointed brigadier of the 9th Infantry Brigade, at present at Camp Borden, Ont.

E. M. PROCTOR, B.A.Sc., structural designer, Department of Railways and Bridges, City Hall, Toronto, has joined the staff of James, Loudon & Hertzberg, Toronto.

EDWARD MURRAY WRONG, eldest son of Professor G. W. Wrong, of Toronto University, and Fellow of Magdalen College, Oxford, has been appointed vice-principal of the School of Technology, Manchester.

W. A. DUFF, A.M.CanSoc.C.E., engineer of bridges, Canadian Government Railways, Moncton, N.B., who has been suffering from blood poisoning at Halifax, N.S., has recovered and resumed his duties.

HENRY CLARK, Canadian manager for Head, Wrightson and Co., of Stockton-on-Tees, England, bridge and mining machinery manufacturers, left Victoria, B.C., early last month to proceed to the firm's headquarters in England on business.

H. B. MUCKLESTON, M.Can.Soc.C.E., assistant chief engineer, Irrigation Branch, Natural Resources Department, C.P.R., who has been located at Brooks, Alta., is now a captain in the 4th Pioneers Overseas Battalion, and is in Ottawa prior to going overseas.

JOHN L. LANG, of the engineering firm of Lang & Ross, Sault Ste. Marie, Ont., has volunteered for active service and has been appointed captain in the 242nd Battalion now forming at Montreal, a forestry unit of which Lieut.-Col. J. B. White is the officer commanding.

J. MACGREGOR, superintending engineer, Halifax Ocean Terminals, Intercolonial Railway, was entertained to dinner at Halifax, N.S., recently by a number of friends and presented with regulation military binoculars by the Board of Trade on leaving for camp preparatory to going overseas with the 239th Construction Battalion, in which he has a commission as a major.

## OBITUARY.

ERASTUS LONG, president of the E. Long Manufacturing Co., Limited, and chairman of the Orillia Water, Light and Power Commission since its inception four years ago, died in Orillia on October 4th after an illness of several months.

LIEUT. J. R. GRAHAM, of the Royal Field Artillery, who was well known in Western Canada, has died of wounds. In 1907 he took up the profession of civil engineering and worked for the Canadian Northern Railway in British Columbia, where he undertook the first survey of the Peace River block. He lived in Vancouver for six years prior to going overseas.

ERNEST W. P. ROBINSON, surveyor, was drowned in Sturgeon Lake, Man., recently. Mr. Robinson was born in England and came to Canada about fifteen years ago. He was a Dominion land surveyor, and for some years did base line work for the Topographical Surveys Branch of the Department of the Interior, but for the last two years devoted his time to his mining interests at Beaver Lake and vicinity.

J. HOWARD JACKSON, head of Jackson and Co., civil engineers, of Brantford, Ont., died on October 7th, following a paralytic stroke. He was born in England in 1847, and went to New Zealand in the early sixties with his parents and took up surveying. When the Maori war broke out he enlisted in the Auckland Engineers, and earned the New Zealand war medal for his services. Some three and a half years ago he came to Brantford, joining his son in the civil engineering business.

## 1916-17 PROGRAMME, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The programme of meetings of the Canadian Society of Civil Engineers, as arranged for the 1916-17 season, has been announced, and among the papers and discussions which are to be presented are the following:—

Dr. J. S. Bates, director, Forest Products Laboratories of Canada, "Forestry"; Mr. E. L. Cousins, chief engineer, Toronto harbor, "Toronto Harbor Works"; Dr. A. Stansfield, McGill University, "Progress in Metallurgy"; Mr. H. G. Hunter, New York Continental Jewell Filtration Company, Montreal, "Progress in Water Filtration"; Mr. T. L. Crossley, Dr. J. T. Donald Laboratory, Montreal, "Asphalt Pavement and Asphalt Testing"; Mr. W. H. Sutherland, assistant engineer, Montreal Water and Power Company, "Montreal Water and Power Company's Reservoir"; Mr. S. P. Brown, chief engineer, Mackenzie, Mann and Company, Limited, "C.N.R. Tunnel"; Mr. Lesslie Thomson, Dominion Bridge Company, "Transmission Towers"; Mr. J. L. Weller, chief engineer, Welland Canal, "Welland Canal"; Mr. D. H. Nelles, "Ottawa Water Supply"; Mr. L. M. Jones, city engineer, "Port Arthur Waterworks"; Mr. William Storrie, "New Toronto Water Filtration Plant."

The meetings will be held at the society's headquarters, 176 Mansfield Street, Montreal: October 19th, general section meeting; November 2nd, monthly meeting; November 16th, electrical section meeting; November 30th, mechanical section meeting; December 14th, monthly meeting; January 4th, mining section meeting; January 18th, monthly meeting; February 8th, general section meeting; February 22nd, monthly meeting; March 8th, electrical section meeting; March 22nd, mechanical section meeting; April 5th, monthly meeting; April 19th, mining section meeting.

Mr. Walter J. Francis is chairman of the committee on meetings; Mr. J. Duchastel, chairman, and Prof. H. M. MacKay, vice-chairman, general section; Mr. J. C. Smith, chairman, and Mr. J. de G. Beaubien, vice-chairman electrical section; Mr. J. M. Robertson, chairman, and Mr. F. B. Brown, vice-chairman, mechanical section; Prof. H. E. T. Haultain, chairman, and Prof. J. B. Porter, vice-chairman, mining section.