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The Canadian Engineer

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Economics of the C.N.R. Tunnel at Montreal

Some Problems in Location That Arose When Seeking An Entrance Into That City—Observations and Anecdotes Regarding Construction Difficulties—May Extend Electrified Zone to Ottawa—Paper Read Before Engineering Institute's Toronto Branch

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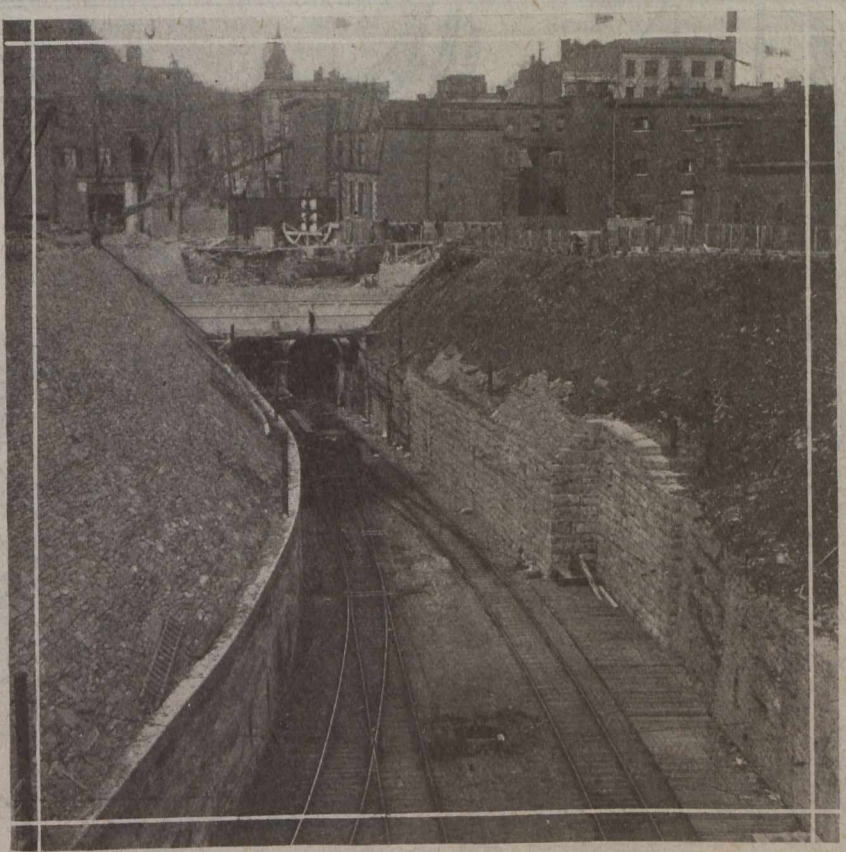
BOTH by temperament and training, it is the economic side of things which has always appealed to me most. Railways are commercial concerns, and the tunnel is an essential part of a great railway. If it cannot be justified in a commercial sense, if it cannot pay interest on its cost, it has no right to exist. This economic aspect of engineering works has come into great prominence of late years, and notably since the introduction of railways. Nearly all our great tunnels have been built to carry railways past, or under, obstructions of one kind or another, so that the history of tunnelling is almost altogether confined to the last seventy or eighty years, and most of the great tunnels are much younger than that.

Railway construction started on a large scale first in England, where population was already dense, and traffic was waiting to be carried in large volume. A railway once built, even on what we should now consider very crude lines, was practically sure of paying its way from the very start, and the cost was a minor consideration as soon as the potentialities of the steam railway came to be understood.



THE MONTREAL PORTAL OF THE C.N.R. TUNNEL

It was when the building of railways extended to this continent of great distances, and at the same time sparse population, that it was found that not only were fixed charges a very heavy drain on railway earnings, but that capital was very hard to get in any case, and had to be brought in from outside, hence the difference in cost between the early American roads and the English ones, and the expedients of sharp curvature, heavy grades and cheap construction, which were used to reduce the capital cost; and hence the fact that so much English capital went into American roads.

As time went on, and the traffic became heavier, and as, too, other lines were built between the same termini and competition became keen, there came the era when the balancing of cost against more perfect location and construction began to be a regular study, and while I think a good many of the earlier engineers (Latrobe, for instance) had thought a good deal about these matters (their works showed that they did), it was Wellington who first committed his ideas to paper, and his writings are still useful as well as monumental.

The element of location which conduces more than any other to reduce the cost of haul, is, of course, that of gradients, and in reducing gradients in rough country there is very often a strong temptation, less often an absolute necessity, to resort to tunnelling. Hence nearly all our tunnels are in the two great mountain ranges of the continent, one east and the other west of the Mississippi River. There are a few, however, on this continent, for the construction of which there are other or contributing causes; and a great many on the other side of the Atlantic,—cases where property damage was to be avoided at almost any cost, or where navigation interests were paramount and a tunnel was more practicable than a high level bridge. The Detroit-Sarnia and Hudson River tunnels are instances of the latter class, and the Baltimore and Washington tunnels are instances of the former, and to this class our own Montreal tunnel also properly belongs.

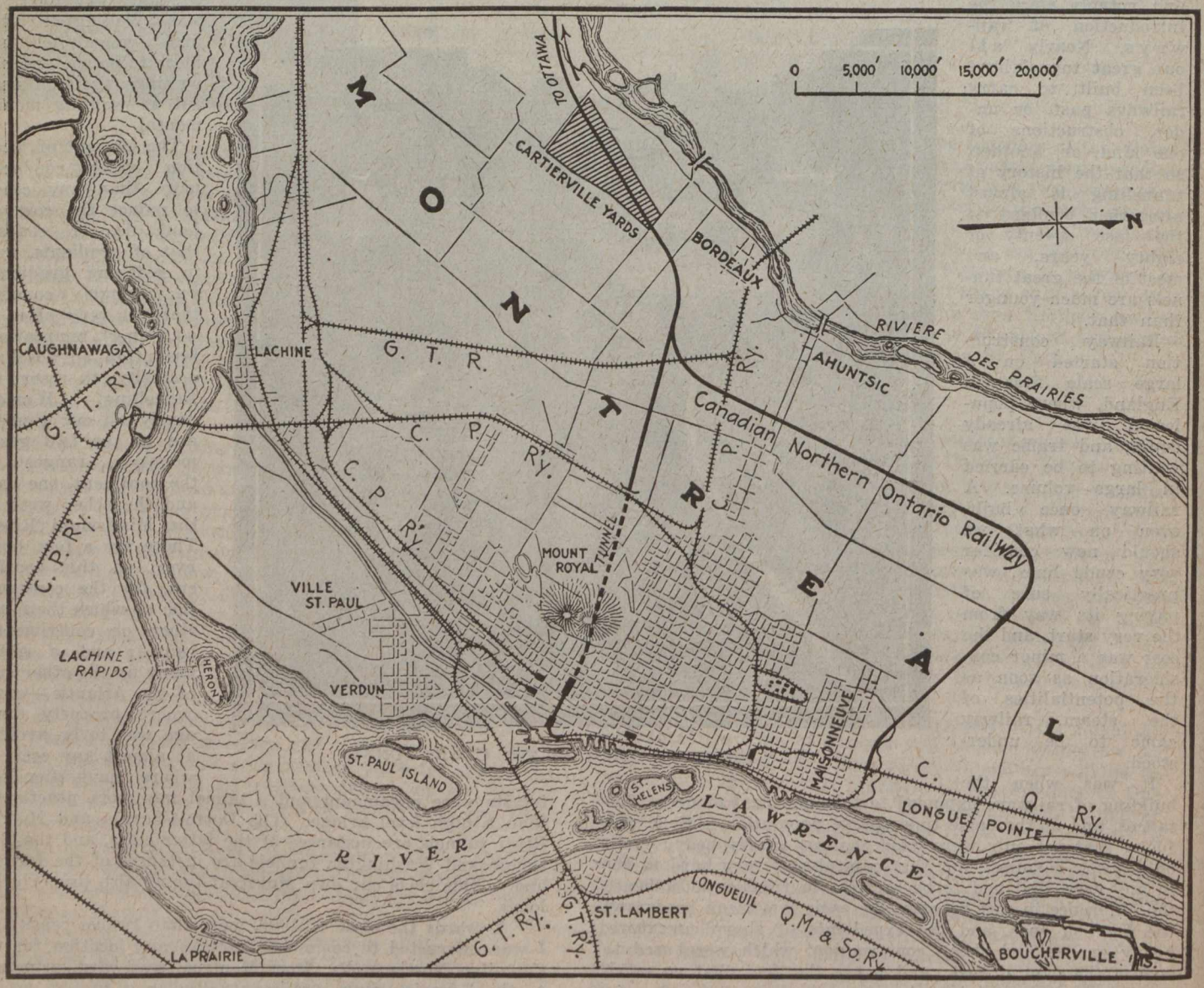
Towards the close of 1906, more than twelve years ago, I was instructed to commence surveys and location for the Canadian Northern Ry. from Montreal westward, primarily to the Georgian Bay, and eventually, as it turned out, to

Port Arthur, to connect with the western system which had already developed to very considerable proportions. My headquarters were at that time in Montreal, so that it was natural that a great deal of my spare time should be devoted to what was in any case the problem of greatest interest and best worth studying out. Montreal and its problems and growth were not a new matter to me, for I had spent three years of my earlier life at McGill University and had geologized on Montreal Mountain with Sir William Dawson.

The Canadian Northern, two or three years before had purchased and completed the Chateauguay & Northern Ry. from Hochelaga to Joliette, and about the same time acquired the Great Northern Ry. of Canada, extending from Hawkesbury to Riviere a Pierre on the Quebec & Lake St. John Ry., which constituted a sort of overflow system by which part of the grain brought from Parry Sound by the Canada Atlantic found its way to an elevator in Quebec. The Superintendent of this eastern system was offered one of the farms near Longue Pointe, and we combined to purchase this for the railway, and by this means secured an approach to the river front, and within a very short time thereafter, a connection with the Harbor Commissioners' tracks. This had already secured for the road an ocean terminal, and it developed later that from this farm, now the Longue Pointe yard (and a very busy yard indeed), there extended a very marked depression clear across the island to the Riviere des Prairies, and the only one of its kind between Racine and Bout de l'Isle. Everywhere else there was a high, broad-backed ridge of limestone to the north of the mountain itself, and to the south a long talus slope of sand and glacial drift.

War Hindered Financing of Big Terminal, So This Temporary Depot Was Built

The Northern Colonization Ry., afterwards the Quebec, Montreal & Occidental Ry., and now part of the C.N.R., climbed over the top of the limestone at Mile End, at an elevation of 200 ft. above the river, and down again with a very strenuous grade of 90 ft. to the mile, to Hochelaga. The Ontario and Quebec Ry., the C.P.R.'s



Plan Showing Railroad Entrances into Montreal

entry from the southwest, climbed over talus debris, and dropped similarly, although not so viciously, to the Windsor St. Station.

Our discovery gave us an entry somewhat circuitous, it is true, but with a short maximum grade of 30 ft. to the mile. This, then, was the obvious route for a freight line from the west to Montreal harbor, and it must be remembered that the C.N.R. was at that time purely a granger road and interested almost exclusively in the hauling of wheat to the seaboard.

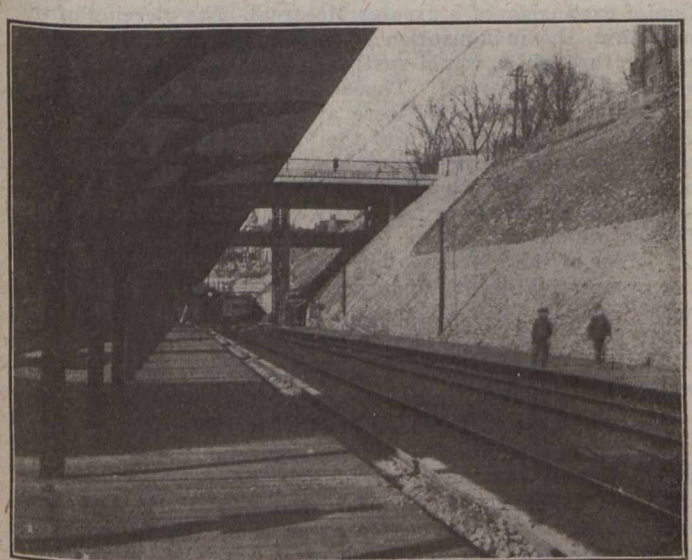
Here, therefore, was the starting point of the survey to Port Arthur, and we still hope to see this line built at a very early date.

Development of Transcontinental Route

The surveys west showed that an excellent line could be had north of the Great Lakes to Port Arthur at moderate cost; in proportion to cost probably the best long distance line in the world. The Pacific coast extension also gave wonderful results, and the system promised to be easily the best of all the transcontinental lines on this continent or any other. While, however, this arrangement was entirely satisfactory as regards through freight traffic to and from the west, it did not meet the requirements of the local traffic, both passenger and freight, of the city itself. Moreover, a transcontinental, such as that described, must of necessity have a suitable terminal in the eastern metropolis to make it complete and well balanced, and this became the new study of the location staff.

Montreal proper, as everyone knows, and many have said, is wedged in between the river and the mountain, on a narrow strip of territory consisting first of a river flat half a mile wide, and farther back a terrace 70 ft. higher, and of about the same width, extending to the mountain slope.

Up to thirty years ago, the site was an ideal one for a city of moderate size, although even then it was remarkable among American cities for its density of population. While Toronto was building up, with detached houses with lawns and gardens, Montreal adhered to long terraces of houses of grey limestone, built right up to the street, and extending for miles almost without a break. Only on the slopes of the mountain the "seats of the mighty," of the Allans, the Redpaths, the

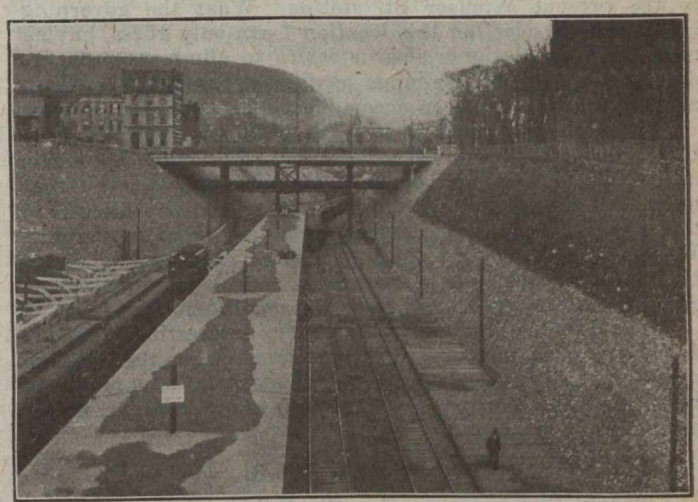


TRAIN EMERGING FROM TUNNEL AND APPROACHING DEPOT

Angus's, and other merchant princes showed more attractive surroundings, even if built on a sharp slope. Westmount was then in its infancy and was deterred in its growth by the long distances from the commercial centre of the city.

Thirty years ago was marked by the advent of the C.P.R. and the selection of Montreal as its headquarters. Montreal began to grow very rapidly indeed, and is said to be increasing in population nearly 10% a year, and has now a population of over 800,000. Montreal a few years ago had an area of 19 square miles, and a population of 580,000. Cleveland, with about the same population, occupied 45 square miles; Boston, with 670,000, covered 43 square miles. Between 1900 and 1910 Montreal added 10,000 people to each square mile, New York only 4,000 and Chicago only 2,500.

Montreal, to use the words of a writer in an American paper, was "choking to death for want of room." In its efforts to find this it has extended down the river almost to Bout de l'Isle, and upward almost to Lachine, and answers much more closely even than Duluth itself, to the Eastern



TRAIN AT RIGHT EMERGING FROM TUNNEL AND PASSING BENEATH DORCHESTER ST. BRIDGE—IN THE BACKGROUND IS MOUNT ROYAL

Yankee's description of that city as being "25 miles long, a mile wide, and pretty nearly a mile high."

Some long-sighted men (Sir William Van Horne for one) had repeatedly cast wistful and prophetic eyes towards the hinterland, "the great beyond" on the other side of the mountain. The Montreal Tramways Co. built a line around it, and Sir William suggested a tunnel of about 1,000 ft. to reduce the extreme summit of the Cote des Neiges hill. Only at one point had any actual expansion in this direction taken place, and this was largely due to the C.P.R. Mile End station and the Tramways Co.'s extensions to it. This was along the extensions of St. Lawrence, Main and St. Denis Streets, and later of Park Ave. This question of city expansion was one consideration which led to the conception and inception of the Montreal tunnel, but it was not by any means the only, or the principal one.

Topography

To most Canadians the mention of the St. Lawrence suggests a river running east and west. It carries east and west commerce, and Sault Ste. Marie is pretty nearly due west of Montreal, and Port Arthur only three degrees farther north; but the St. Lawrence proper, from Lake Ontario to the sea, flows northeast, and at Montreal it runs almost due north and south. It is the Ottawa which is the east and west river, and it is the Ottawa valley which has been in the past the great highway of commerce, and which has resumed this place as the route of the two transcontinental roads. The result is that the direct route from the heart of Montreal to the west, lies directly through the mountain, and almost at right angles to the river and the great thoroughfares of St. Catherine, St. James and Notre Dame Streets which parallel it. As grade separation was an essential feature of any terminal scheme, this was a very important consideration.

Three railways had already entered Montreal from the west. The Grand Trunk entered it when the problem was a comparatively simple one. The Victoria bridge was located at what was considered the best point for a bridge, as was the St. Anne's bridge over the Ottawa. The intermediate line was built as directly as possible between them, and one of the pioneer roads of Canada, the Lachine Portage Ry., was used as an approach to a dead end station in the

outskirts of the city at that time. The main line did not touch Montreal as it then existed.

Thirty years later, the Northern Colonization Ry. was built from Ottawa, and it climbed over the northern toe of the mountain and entered the extreme northern end of the city, and, after absorption by the C.P.R., the Place Viger station.

Ten years later still came the Ontario & Quebec Ry., which paralleled the Grand Trunk from Vaudreuil to Dorval, and then rose over the terrace and followed along its edge to the present Windsor St. station. What the governing ideas were in selecting this location I can only guess, having never met the designer, but a desire to eliminate property damages and grade crossings as far as possible is evident, and the solution has been accomplished in a very clever way.

It is on the whole a very satisfactory entry, but the C.P.R. is under the disadvantage, with the double approach, of having to keep up two separate terminals and a great number of passengers have to travel across town from one to the other, in coming, for example, from Quebec to Toronto. It may almost be said that there are three terminals, for the Mile End station is getting to be very popular with short distance passengers to and from the north and west.

The Windsor St. approach is very interesting, not only as a very good piece of work, but as showing the development of railway ideals, and the demands of the public in respect of abolition of crossings and concealment and suppression of smoke and noise.

Advent of the C.N.R.

Nearly thirty years after the C.P.R. comes the Canadian Northern. Thirty years makes a great difference in a problem of this kind. Land values have grown prodigiously in the meantime, due to the ever-increasing congestion. And the education of the public, assisted by a railway commission anxious to please it, has gone on apace. Grade separation has become absolutely essential, and the absolute abolition of smoke and noise almost so. At the same time, and from the railway point of view, passenger trains have become longer and heavier, and harder to haul, so that grades must be flattened to the utmost, especially in regard to starting and stopping. Maintenance-of-way and operating expenses have been increasing in a much faster ratio than the corresponding passenger rates and receipts. Only the increasing volume of traffic offset the growing discrepancy and served to stave off the bankruptcy of the railways.

The passenger business alone was not the only thing to be considered. The Grand Trunk, during its sixty years of occupancy, and the C.P.R. during its shorter term of existence, had surrounded and honeycombed Montreal with a network of industrial spurs, sidings and yards, in every direction. The Canadian Northern had only one small yard in the extreme north end, and its connection on the same terms as the other lines with the Harbor Commissioners' tracks for overseas business. But business to and from the local industries, the wholesale houses, cold storage plants, etc., has to be hauled from three to five miles by motor trucks to Moreau St. The handicap is altogether too great. In the district bounded by McGill St., the Lachine Canal, Windsor St. produced, and Lagauchetiere St. alone, there are something like 150 of these smaller industries and plants, and a great many more within a mile radius of the Haymarket square. Passenger business may perhaps be described as the spiritual and intellectual function of the railway body corporate, but freight is the wholesome and nourishing food which enables it to do its work and carry on its functions. The passenger service is the side which appeals to the ordinary layman passenger, just as a man's face and bearing does to a new acquaintance, but he cannot keep up the prepossessing appearance unless he has his stomach full, and some little money in his pocket.

We have here a number of essentials to be provided for and a still greater number of desiderata, also many things to avoid. The most important necessity of all at the moment perhaps was the finding of the necessary capital. Railway terminals are expensive things at the best, and this was an era of extravagance in this respect. The Pennsylvania had spent many millions on its New York entry. The New York Central was following suit with a magnificent scheme, better balanced financially, but still enormously expensive. Kansas City was building a joint $45,000,000 terminal, and St. Paul was considering a scheme which involved encroachment on the rights of its very respectable and oldest citizen, the Mississippi River—almost as old and respectable as the Montreal mountain itself, although somewhat dirtier.

But these were all in connection with roads of long standing and financial strength. They were improvements and consolidations rather than new schemes. The Canadian Northern, while it had been earning at a great rate, was also extending and building equally fast, and had largely discounted its future in its borrowings. Even in a growing northwest, it takes some months before a new piece of road can earn its own living, and some of the C.N.R. construction was of a nature and through such country as could not be expected to yield any adequate income except as part of the completed system.

Selection of Route

The most obvious route was to parallel the two older roads and it was very seriously proposed, but the writer for one never took to the proposition. It was neither the inexpensive route of the older Grand Trunk, nor could the very neat grade separations which the C.P.R effected thirty years ago be repeated and duplicated. The C.P.R. line had been badly bent in order to effect its entry. Everything pointed to the north, instead of the south shore of the Ottawa, as being the Canadian Northern's proper route, and in this case the bend would become a right angle elbow. The right of way would be absolute destruction for two miles or more, and grade separation could be effected only by a continuous track elevation for the same distance. It would have been plagiarism of the worst and most expensive type. It was proposed to join with the Grand Trunk, but this would merely have mitigated some of the evils of parallelism, not removed them, and the Canadian Northern would have lost its identity and its independence at a most important point, and neither of these propositions would have been any solution of the freight problem.

The tunnel was the obvious solution of the whole question, and it was adopted by the writer at a very early stage, but how was the money to be found? Here came in the question of expansion, of a greater Montreal. The piercing of the mountain, the inauguration of a fast and frequent electric service through it, would vastly enhance the value of the inaccessible lands beyond. Thousands of acres, sloping gently towards the Back River, were available, if they were once brought within easy reach of the business and shopping district. As soon as the program was announced, real estate men would quickly absorb all the available land, subdivide it and sell at enormous profit. Why should not a syndicate be formed which would take this part of the business out of the hands of the real estate men, buy up the land and out of the prospective profits finance the construction of the tunnel? The idea once suggested took root, and some of the great financiers of the world became directly interested in it, and the idea of the tunnel entrance became an established one.

Construction Considerations

But this merely fixed the principle of the tunnel, not the line of it, and there were several lines suggested other than that adopted. A line just south of Park Ave. was strongly advocated, the reason given being that it would be closer to the surface and much of it could be built by the cut-and-cover method. It was pointed out in rebuttal that this would disorganize all the underground economy of the district, sewers, water pipes and gas, and that the streets would be impassable and the abutting property uninhabitable during the whole time of construction, unless the enormously costly methods of the New York subways were adopted. So far from being an extravagance, the bold line under the highest part of the mountain was the cheapest, in that it avoided all property damage, except for about 2,000 ft. on the city end.

This argument prevailed finally and the bolder line was adopted, but there was still a good deal of latitude in the

choice of line. At the west end a long strip of property was offered reaching nearly to the Back River. It so happened that on this property was the best point at which to cross the C.P.R.'s Atlantic and North Western line, so this end was promptly and satisfactorily settled.

The east end was the subject of longer debate and some warmth of argument. Most English-speaking people think of Montreal as extending from the mountain to Dorchester St., and from Park Ave. to the confines of Westmount, with an addition for business purposes extending east and south for half a mile from the Place d'Armes, and of St. Catherine St. as being the main and only important artery.

This is only a small part of Montreal in reality, but the conviction in the Anglo-Saxon mind that this is Montreal, the whole of Montreal, and nothing but Montreal, is almost as fixed and ineradicable as the Englishman's idea that the whole world is centred about his own tight little island.

As a result of this obsession, it was difficult to get any site off St. Catherine St. even seriously considered. A line near University Ave. was actually adopted, and abandoned only when it was shown that this was of no use except for purely passenger business; that there was no chance for extension eastward, and that it must for all time to come remain a dead end branch six miles long, and worse in this respect than either the C.P.R. or the G.T.R.

Finally, the present line was adopted mainly for the reasons that it gave a continuous line from the mountain to to the water front, with opportunity to connect with the Harbor Commissioners' tracks, and through them with the system extending to Quebec and Chicoutimi; that in doing this it passed through some of the best freight-producing districts in Montreal, and that it did all this with a minimum of property damage and with an absolute avoidance of grade crossings or even distortion of street grades.

There is further, an avowed intention on the part of the Harbor Commission to build a dam across the river to St. Helen's Island and a bridge from it to the east shore, which will furnish a route for such roadways and railways as care to avail themselves of it.

It is more than probable that the Quebec, Montreal & Southern and the Intercolonial will avail themselves of the chance, for the Grand Trunk's great bridge is already congested and overcrowded; but this is a matter for the future.

Grades Through Tunnel

Closely allied to the question of alignment, and in some respects even more important, is that of grades. I have already alluded to the increasing length and weight of passenger trains. The C.N.R.'s standard transcontinental train averages eleven cars, and with this its Pacific type locomotives get over the 1% grades of the Lake Superior Division with reasonable ease.

On the other hand, if the grade is flattened too much, on a long tunnel and approach such as this, trouble with drainage is apt to occur, especially in winter. The grade through the tunnel is 6/10 of 1%, or 32 ft. per mile, and is continuous from end to end; the west portal being thus 100 ft. higher than the east. From the west portal the same rate of grade carries us down through the Model City for nearly the same distance. The long cutting on the west approach, was introduced with a purpose, viz.: to allow the civic expansion to go on overhead without too much distortion of street grades.

In consideration of the electrical operation, the headroom required under the bridges was reduced from the regulation 22½ ft. to 16½ ft., and the problem of grade separation rendered so much the easier of accomplishment. Near Cartierville the Montreal Park & Island Ry., and a main road alongside it, have been carried underneath. Absolute grade separation is thus secured, not only through the city itself and its transmontane annex, but for the entire length of the electric zone, nearly nine miles; and Cartierville, a promising suburban settlement on the bank of the Riviere des Prairies, is now brought within eighteen or twenty minutes of the heart of the city.

The tunnel itself is a very interesting one and ranks among the great tunnels of the world, being 3.25 miles long. Only the three great Alpine tunnels, the Mount Cenis, the St. Gothard and the Simplon, completely eclipse it in length, and there is only one in Canada which is longer, the C.P.R. Rogers Pass tunnel.

It was predicted beforehand that the difficulties would be comparatively few, and so it turned out. Very little water was met with, and this where it was expected, near the west portal, at the contact between the limestone and the older rocks on which it rests uncomformably. The core of the mountain was almost exclusively Essexite, a basaltic volcanic rock, somewhat hard to drill, but otherwise quite unobjectionable.

Concrete Lining

It was at first thought that most of it would not require lining, and had it been a steam operated road in the open country, it is quite probable that very little lining would have been put in, but its nearness to the terminal, and the adoption of the trolley system, which meant support from the roof, made even a small fall a very serious matter, as it would both delay and endanger the traffic. Some little seaminess and disintegration showed itself after exposure to the air, and in the end all of it except about 1,000 ft. was lined with a thin sheeting of concrete. This applies to the rock section.

For something over half a mile at the city, or east, end, the roof ran into clay, although the bottom and most of the wall remained in limestone. This clay was known beforehand to exist, and it is of a very plastic and semi-fluid formation and contains numerous shells such as now exist in northern seas. On account of its semi-fluid nature, and because this section led under streets and close to the foundations of buildings, it was decided to take this out under a shield protection, the shield being followed up with an arch of concrete blocks pre-cast in voussoir shape.

Practically no leakage, even of water, was ever visible during the progress of the work, and yet considerable settlement of the street overhead took place. Probably the moisture evaporated and escaped as invisible vapor. A great many of the houses had been set down on this soft clay and had suffered from settlement before the work was started; the further settlement was therefore of less consequence than it would otherwise have been. Through this section the individual tracks are carried in separate tunnels with a thin wall between them. The same is true of a few hundred feet at the west portal, but the body of the tube is a single opening.

The heading was a "bottom" one, 8 x 12 ft., and was put through with very good speed. For a time, in fact, the American record for hard rock tunnelling was broken by an average advance of 26 ft. a day for a whole month. As soon as a sufficient advance had been made, the enlargement to full section was commenced, the arch being taken out first, and the two "benches" afterwards.

As the east end is in the city and there was no means of getting rid of large quantities of material except by teaming for several miles, this work had to be done from the west end, and for this reason the heading was driven faster from this end, and this meant working down hill. Under these circumstances the small flow of water was particularly fortunate, as the amount of pumping was small.

Shafts

In order to expedite the work, a 250-ft. shaft was sunk one mile from the west end. This made it possible to follow up with the enlargement on the westerly mile without interference from the heading from the shaft, but as a matter of fact the rapid progress of the heading was to a large extent wasted, because the war intervened, and work on the enlargement was impeded by the difficulty in finding the necessary capital to carry it on.

The shaft was, however, designed to carry an elevator in the future to a substation at its foot, and with this in view, was sunk to one side the centre line of the tunnel. This, as may be imagined, greatly increased the difficulty of alignment of the tunnel. To offset a line on the surface, to two plumb lines, only some 12 ft. apart and 250 ft. long, and then offset this line again at the bottom of the

shaft, was an operation requiring care and patience, but it was accomplished without appreciable error by H. T. Fisher and his staff.

A second shaft was sunk, some 70 ft. just to the north of Sherbrooke St., and at the bottom of this the shield was put together.

A third shaft was projected at Pine Ave., but considerable opposition was met with from the wealthy residents of the neighborhood, and it was abandoned, and undoubtedly the advantage from it would merely have expedited the driving of the heading, not of the completed tunnel.

A fourth shaft was sunk on Dorchester St., and it was from this that a large quantity of material was removed, because there happened to be a very large and almost vacant piece of property at this point, on which material could be wasted for the time being, until the tunnel became available for hauling it away.

Anecdotes

The chief engineer in charge of the tunnel construction, S. P. Brown, in his enthusiastic belief in and support of everything connected with the tunnel working, got into some rather amusing situations which he relates himself with considerable humor.

On one occasion he was dining in a house almost over the line of the tunnel, and his host took occasion to remonstrate against the heavy blasting which sometimes shook the house and made his women folk nervous. Brown assured him that this had been stopped altogether and only the lightest of charges were being used, and especially at night.

Just then a tremendous shot was fired, and all the front windows were smashed. It was a very embarrassing moment, and Brown had some difficulty in preserving his dignity and his host's respect.

On another occasion a discussion arose with reference to the effect of the vibration occasioned by moving trains on some of the delicate instruments in McGill University, which is almost immediately over the line of the tunnel; the seismograph, for instance, which is intended expressly for recording terrestrial vibrations.

Brown stoutly maintained that there would be no effect whatever, and that in New York a similar instrument near the subway had taken less notice of the blasting and the subsequent train running than it had of the San Francisco earthquake 3,000 miles away.

He suggested that the instrument be set up in a basement on McGill College Ave. while a blast was being fired, and they would see for themselves how absurdly small the effect was. The suggestion was acted on, the instrument set up, the blast fired,—and the seismograph went out of business altogether!

(NOTE.—The blast was a heavier one than Mr. Brown intended to have fired; and the fact that the weather was unusually cold and the ground frozen very hard, intensified the effect. The shock broke grate bars of furnaces in houses on McGill College Ave., so it must have been severe. We believe that Mr. Brown was correct in his contention regarding the seismograph in New York City.—EDITOR.)

Reasons for Electrification

As mentioned previously, the tunnel was planned from the beginning for electric traction. No effort was made to avoid the inevitable in this respect. It was felt that while very much cheaper in initial cost, a steam service through such a long tunnel would not be popular with the public; fans and artificial ventilation would have to be installed; and that even outside the tunnel, on the city end, there would be a strong opposition to steam operation over the streets, and justly so, for Montreal is already more saturated with coal smoke than even Toronto.

Some will remember the fatal disaster in the St. Clair tunnel, when it was operated by steam locomotives, although this is not much more than one-third the length of the Montreal one. Some minor mishap necessitated a stop at the lowest point in the tunnel, and some of the train hands were asphyxiated by the waste gases from the locomotive before help could be got to them. Even on a passenger train, although the trip lasted a very few minutes, there was a certain sense of suffocation and a feeling of relief when the trip was over. This accident precipitated the inevitable change to electric traction, and in the case of the Pennsylvania and Detroit tunnels, electricity was installed from the very first.

In the Montreal tunnel, in actual experience, the air is just as fresh as it is outside, and there is quite a marked natural circulation through it. The air at the city end is nearly always warmer than that at the west, or country, end, and rises from the terminal excavation, causing a strong draught of cool air from west to east. With the west end warmed up by a westerly sun, while the east is in shadow, the current will very probably be reversed, but the normal conditions seem to be as above.

The electrification work, which is a very interesting study in itself, was under the very able charge of W. C. Lancaster. A study was made for developing power at St. Ursule Falls, on the Canadian Northern line, some sixty miles east of Montreal, and transmitting to Montreal, but the power was not very reliable and to make it so meant a lot of interference with vested rights and privileges, which threatened to raise the capital cost and resultant charges to a point which meant that it would cost more per horse-power than it could be obtained for from the Montreal Light, Heat and Power Co., and an arrangement was made with that company to supply the necessary power.

The system is a direct current of 2,400 volts, much higher than we have been accustomed to up to the present. The 80-ton locomotives take the current from a trolley wire by means of a pantograph. The third-rail system was considered, but on account of the heavy snowfall at Montreal, and occasional accumulations of ice, it was not considered desirable. In actual test these locomotives haul a 7 or 8-car train against the adverse 6/10 of 1% grade through the tunnel in 7 minutes, or practically 30 miles an hour.

May Extend Electrified Zone

The electric zone extends at present only to Cartierville, which on account of its being a convenient point at which to establish a divisional yard with locomotive house and shops, was considered the best point at which to make the change. It is altogether probable that as the intermediate country gets settled up with suburban residences (a movement which has already commenced), it will be extended to St. Eustache, a very prosperous town with beautiful surroundings; and we hope, eventually, to Ottawa. Only the heavy cost of installation prevented this being done in the first place. The route to Ottawa, lying as it does along the banks of the river, and generally within sight of it and of the Laurentian Hills beyond, is quite the most attractive of the four existing ones, and within a mile of being the shortest. It has already made a good start in popularity; and with the additional attraction of electric traction, it should pretty nearly monopolize the business.

At the annual meeting of the Ottawa Branch of the Engineering Institute of Canada held January 9th, the following officers were elected for this year:—R. deB. Corriveau, chairman; J. Challies, secretary; members of the managing committee, A. F. Macallum, C. N. Monsarrat, J. Blizard and G. B. Dodge.

At a meeting of the Sault Ste. Marie branch of the Engineering Institute of Canada, held about two weeks ago, F. F. Griffin read a paper on "Efficiency Acceptance Tests of a 3,200 h.p. Water Turbine." The following were elected as the 1919 executive; J. W. LeB. Ross, chairman; L. R. Brown, secretary-treasurer; R. S. McCormick; B. E. Barnhill; A. G. Tweedie; and J. H. Ryckman.

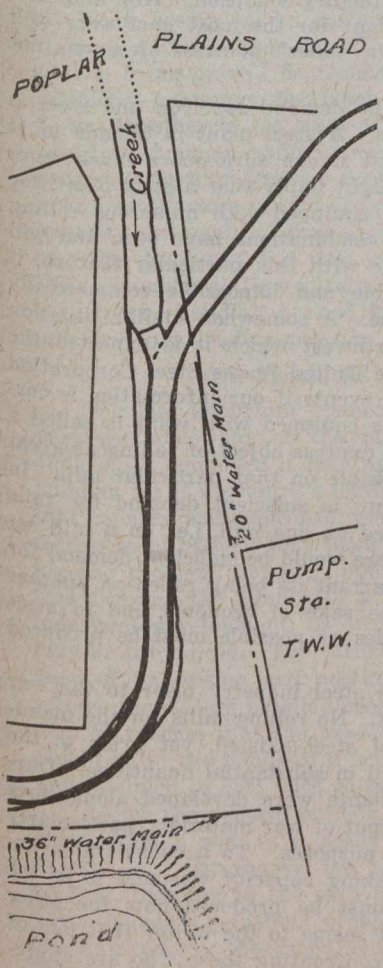
The Civil Service Commission of Canada (William Foran, Ottawa, secretary) announce that applications will be received not later than January 31st for an engineer on the staff of the chief engineer of the British Columbia Hydrometric survey, at a salary of $1,500 per annum. Candidates must be graduates in engineering of some Canadian or British university, and must have had at least two years' experience in field and office engineering.

ROSEDALE CREEK SEWER EXTENSION, TORONTO

Circular Brick Sewer 2,598 Ft. Long, 6 Ft. 6 Ins. Diameter, One Per Cent. Grade—Constructed Partly in Tunnel, Using Compressed Air

WITHIN a couple months, the sewer section of the Department of Works, Toronto, will have completed, by contract, the Rosedale Creek sewer extension, which will take the creek flow at the Toronto High Level Pumping Station, and ultimately will also relieve the St. Clair Ave. sewerage system. The extension is 2,598 ft. in length, of which 332 ft. was built in open cut, and the remainder in tunnel, compressed air being required in the last 500 ft.

The extension commences about 200 ft. north of Macpherson Avenue, and follows the old creek bed toward the pumping station. Skirting the station grounds, the line continues along Poplar Plains Road to the intersection of Russell Hill Road, where provision is made for connection to the existing 15-in. tile sewer which continues along Poplar Plains Rd. The extension then turns into, and follows the windings of, Russell Hill Road to the centre line of Clarendon Road, where provision is made for future extension to St. Clair Ave. and to the junction of the creek at Spadina Road bridge, south of St. Clair Ave.



PLAN SHOWING LOCATION OF BELLMOUTH

The sewer was designed as a circular, three-course wall of hard, red-shale brick, 14 inches in width except for 165 lineal feet where the thickness was increased to 18 ins. The inside diameter is 6 ft. 6 ins., and the outside, 8 ft. 9 ins. and 9 ft. 6 ins. One layer of selected brick was required in the water run for the entire length of sewer.

Suitable manholes, ranging in depth from 20 to 60 ft., were provided at fixed points. Five are typical and two are special drop manholes, the deepest being at the corner of Clarendon Ave. The inverts of two manholes on existing tile sewers were reconstructed and connected to new drop manholes.

An inlet for the creek was built near the High Level Pumping Station. As the creek, in early spring, rapidly dammed with the ice and overflowed the surrounding property, it was necessary to design the inlet to the sewer as a "Y" branch and to enclose the creek itself in a concrete flume for a distance of about 100 ft., connecting with an existing culvert on Poplar Plains Road.

The grade of the new extension is 1 in 100, which is maintained from the creek at Spadina Road (Station 34 + 55) to Sta. 4 + 55. At the latter point, a vertical ramp of 7 ft. head was constructed and the remaining grade to Sta. 0 + 00 is 1 in 122.

Borings were taken by the works department along the line of the sewer extension. The soil ranged from hard blue clay near the creek to running sand on Russell Hill Road.

Work was commenced on the "open cut" at the High Level Pumping Station, where borings showed hard blue clay. As the contractor was required to take care of the flow in the creek at all times and under all conditions, it was first necessary to divert the water. A small dam, about 6 ft. in height, was constructed across the creek bed half way along the "open cut." At this point there was found an old

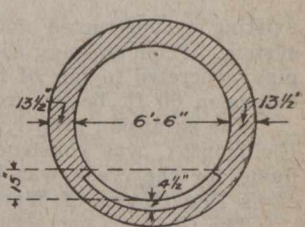
CREEK FLOW ENTERING BELLMOUTH—ICE ON BANKS IS EVIDENCE OF RECENT FLOOD

feed pipe supplying the pond immediately to the east from which soft water is pumped for use in boilers, etc., at the pumping station. At the south-west corner of this pond was an overflow which in time of creek flood released excess water to the brick sewer already constructed at Station 0 + 00. This formed an adequate by-pass for the first section of excavation for the "open cut." The excavation was then effected with the aid of small charges of explosives.

Great care was exercised to ensure the safety of the 36-in. cast-iron water main running parallel to the sewer extension, of the pond immediately to the east, and of the buildings of the pumping station.

The sewer was built in this section, as far as the first temporary dam, with an opening in the top to be used in draining the second section of the "open cut." In the second section, another temporary dam was built to clear the branch of the Wye Inlet. The water passed through 36-in. galvanized iron piping to the opening left in the first completed section, where part was diverted to feed the pond.

The creek inlet bellmouth was built in two sections. Brick was used for the entire lower half of the 6 ft. 6 in. circle. Concrete was then placed, bringing the walls vertically to 8 ft. 6 ins. above the water run. The roof was laid as a reinforced concrete slab 7 ins. thick, supported by three reinforced concrete beams. The creek bed was excavated to the existing road culvert on Poplar Plains Road, the flow of the creek being directed through iron piping to the bellmouth inlet already constructed.



TYPICAL CROSS-SECTION OF BRICK SEWER

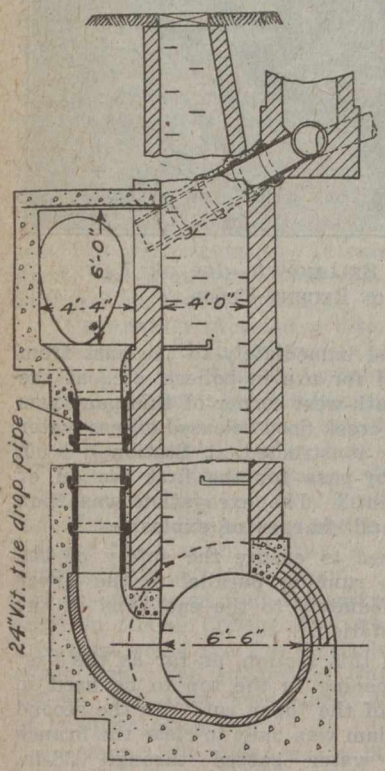
A vertical ramp was constructed in concrete, raising the grade of the invert 6 ft. 2 ins. above the invert of the bellmouth. The ramp changes in design from circular bottom at bellmouth to rectangular at the higher level and continues to the road culvert as a rectangular structure of 8 ft. effective width and 6 ft. effective height.

The roof was poured as a reinforced concrete slab, 12 ins. thick. In this roof two openings were left to permit any possible overflow to enter the sewer. The openings are 9 ft. x 3 ft. and 4 ft. x 2 ft., the larger being upstream.

A 12-inch tile pipe was laid along, and concreted to, the wall of the box flume. This pipe was offset vertically over the bellmouth inlet and was connected to the old feed pipe to the pond. At low water an eighth-inch iron flare diverted the flow of the creek to this tile pipe.

The entire "open cut" and the box flume were carefully backfilled with part of the material removed from the tunnel. The remainder of the material from the tunnel was dumped and spread on private property on Russell Hill Road.

The sewer extension from the bellmouth creek inlet to the corner of Clarendon Ave., a distance of about 2,266 ft., was constructed in tunnel. Five shafts were sunk in addition to the manholes. Work continued at a rapid pace until the ground began to show moisture. The roof and sidewalls were timbered as necessary, and with pumping, this was found to be satisfactory until nearly 1,800 feet had been completed. With 500 lineal feet to finish, the flow of ground water became too great, and the contractor installed an air-compressing plant consisting of a "N.E. 1" steam-driven Ingersoll-Rand compressor, feeding from 15 to 30 lbs. of air into an 8 ft. x 3 ft. steel receiver. Work on this section is now rapidly nearing completion.



ELEVATION OF DROP MANHOLE NO. 8

Manhole No. 8, constructed at the corner of Russell Hill Road and Clarendon Ave., possesses come interesting features. The base is 62 ft. 6 ins. below ground. The manhole chamber is rectangular, 4 ft. x 2 ft. 6 ins. Steel platforms were provided by the city and placed by the contractor at a distance apart of about 10 ft., access being gained by the usual step irons (1¼ ins. x ½ in. galvanized wrought iron flats).

A short section of standard egg-shaped sewer, 5 ft. 9 ins. by 3 ft. 10 ins., is incorporated in this manhole at a depth of 20 ft. below ground, to provide for future extension to St. Clair Ave. Into this egg-section, a 15-ins. tile drains the existing reconstructed manhole of the old Clarendon Ave. system. From this egg connection, a 24-in. vitrified tile drop pipe, concreted to side of the manhole, carries sewage to the extension 60 ft. below ground.

The extension proper, including 7 ft. on the Wye branch (bellmouth), was constructed by the contractor. The box flume for the creek was built by the sewer section of the city's Department of Works.

The Godson Contracting Co., Ltd., Toronto, are the contractors, with H. F. Barker as engineer. *The Canadian Engineer* is indebted to Mr. Barker for much of the above information.

The work is under the direction of R. C. Harris, works commissioner, and of George Powell, first principal deputy city engineer. W. R. Worthington is engineer of sewers; W. G. Cameron, engineer of maintenance and construction.

The annual meeting of the Commission of Conservation of Canada will be held February 17th to 19th at Ottawa.

The annual convention of the American Concrete Pipe Association will be held February 14th and 15th at Hotel La Salle, Chicago.

IRON AND STEEL PROBLEMS

War Has Greatly Altered Position of Industry in Canada—Relation to Labor and the Tariff

BY J. FRATER TAYLOR
President, The Lake Superior Corporation

THE present and prospective standing of the iron and steel industry in Canada is something that is of considerable moment to every Canadian. There are certain industries properly classed as basic industries. Such industries furnish the foundational raw materials for other lines of business. This is particularly the case with iron and steel which enters into most things. A brief consideration will demonstrate that this is so. Steel rails, for instance, are required for railways; structural steel, that is beams, angles, channels, for structures such as ships, buildings and bridges; plates for locomotives and boilers; wire for wire products, including nails, and so on. In order to make Canada self-contained from the double point of view of reducing imports and of providing employment in Canada, it is very essential that above all things the basic industries should be protected and developed. Before the war the steel industry, which previously had been fostered to some extent by bounties, was not in a very satisfactory condition. Iron and steel works existed, the foundations for the most part were well laid, but the outlook from a "sales" point of view was not over satisfactory.

Obviously in Canada the demand for iron and steel is not as in the United States. A steel plant in Canada must be elastic to the extent that it can turn out a much more diversified product. This might imply that a steel plant, for instance, would have to be equipped with numerous rolling mills. This is so but mill combinations have been and will probably be devised to cope with this particular feature, it being obviously impracticable and impossible commercially to meet conditions otherwise. A somewhat similar situation exists in the American northwest which it is expected the Minnesota steel plant of the United States Steel Corporation is designed to reach; at all events if our information is correct that particular plant is equipped with what is called a "combination mill" with the express object of rolling as great a variety of product as possible on that particular mill. In Pittsburg, for instance, there is sufficient demand for rails to warrant their being rolled on one mill, i.e., on a mill set apart for rails only, and there would be sufficient demand for heavy structural steel to warrant its being rolled on another mill, but in Canada for the sake of economy and to meet conditions, as many varieties as possible must be produced from one rolling mill.

We have seen that the steel industry prior to the war was developed up to a point. No rolling mills for the manufacture of heavy structural steel existed, yet prior to the war such steel was imported in substantial quantities. During the war period steel plants were developed along lines which made for a heavy output of war materials, particularly of shell steel for munition purposes. To a considerable extent the increased steel making capacity was and is in the right direction but steel must be produced now for other purposes than shells, and it seems to the writer that one of the most important things confronting those who are studying the carrying on of Canada industrially after the war, must be the development of the basic steel industry with the object of insuring that all wheels are kept turning and that imports are lessened. And further—development should be carried deeper down than in the mere installation of such as rolling mills.

Must Use Low Grade Ore

Canada, especially in its central areas, has not so far located much high grade iron ore but there is a vast tonnage of ores of lower grade, which in order to make them marketable or usable must be treated by roasting or some other process. The cost of roasted or treated ore until the treat-

ment is down to a scientific commercial basis, or until costs of ores from the Lake Superior portions of the United States automatically reach a higher level, must be somewhat higher than the cost of ores that do not require treatment. It is to overcome this period that a bounty or something of the kind on the production of low grade ores is suggested. Bounties are looked upon with a considerable amount of misgiving, but the suggestion is not made that those bounties should exist beyond a period long enough to produce the ores in question commercially. The problem is one which might very properly be examined by a special committee. It would indeed be a matter of great moment to Canada to have those leaner ores developed and mined.

So much then for the basic features in the elaboration of which we have had primarily in view the holding of the domestic market by Canada for Canada.

Labor Element Is Vital Point

There are two important elements of major detail to be considered; one is the question of labor cost and the other the tariff. The cost of Canada's products is vital. This is not a question of the cost of an individual manufacturer's product but Canada's costs as a whole. Is Canada able to keep the cost down, all with a view to insuring that Canada will maintain and develop her position as an exporter? The tendency seems to be towards shorter hours for labor—towards an eight-hour day; I do not know that such a prospect is being or will be received unsympathetically but it is distinctly necessary for labor and what is called "capital" to get together to see what can be worked out, all from the ability-to-compete point of view as the basis. If an eight-hour day through greater freshness of brain or muscle will insure satisfactory output from the factories, both as regards quantity and quality, there should be little to be apprehensive of. The brains of the men in the "plant" must contribute their thoughts, as they surely can do, to the ingenuity necessary to the building up and maintaining of their particular industry in a leading position.

Tariff Should Be Carefully Framed

The last important element is the tariff. Now a tariff partakes somewhat of the nature of a two-edged sword. Judiciously employed it may prove of great assistance in the building up of a country's industry with the object of making that country self-contained, and its continuance from a protective point of view may likewise prove advisable. In studying the problem, however, one can hardly overlook the fact that through the agency of a tariff the capital cost of any industrial development, as well as the manufacturing cost, may be prejudiced. The tariff, especially from the points of view of imposition and administration, should at all times receive the closest possible consideration. It would seem the part of wisdom that the general administration of the tariff should be in the hands of a scientific commercial commission well qualified to deal with so important an instrument.

As for the general outlook, no one can expect that transition from a war to a peace footing can be accomplished without any disturbance, but that disturbance may be more or less according to the skill and judgment brought to bear upon Canada's industrial problems in these times. Between the government, the manufacturer and the direct consumer there should be close co-ordination for the first few years of peace times. It is well to bear in mind that in reference to problems of the kind, most of the thinking should have been done, because the time for action has undoubtedly arrived.

The health officer of the city of Stratford, Ont., announces that there was not a single death from contagious disease in that city of 17,000 population during the year 1918. Typhoid was practically unknown, the four cases that were reported having originated elsewhere. He attributes this remarkable record to improvements to the city's water supply.

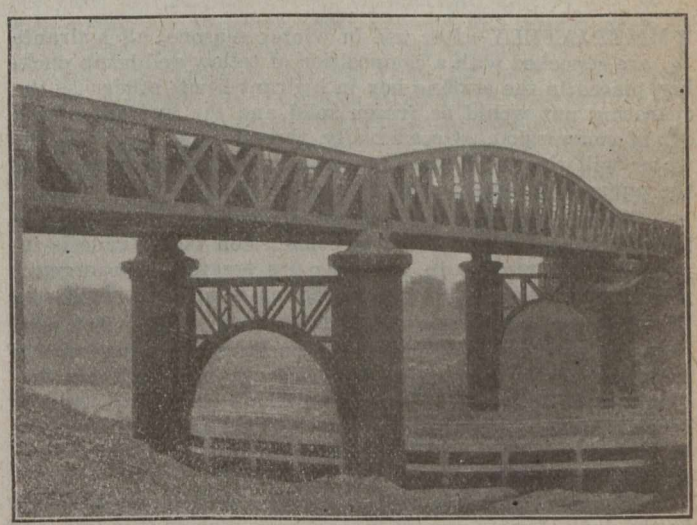
AN ENGLISH RAILWAY BRIDGE*

THE accompanying illustration shows a good example of erection carried out in England, and the following is a description of the work. The bridge consists of a centre span of 112 ft. 6 ins., and two side spans of 59 ft. 3⅞ ins., with a clear width between the main girders of 26 ft. 6 ins., to allow for two sets of rails 4 ft. 8½ ins. gauge.

The clear headway from water level to the underside of the centre span is about 38 ft. 6 ins. The end abutments and wing walls are built of blue brick in cement, with stone and blue brick capping, while the bedstones under the ends of the main girders are of granite.

There are two intermediate piers, each consisting of two cylinders about 56 ft. long. That portion of each cylinder below the ground level is made of cast iron, and varies in diameter from 10 ft. to 7 ft. Above the ground level the cylinders are 7 ft. in diameter, and are built of steel plates and angles, with an ornamental cast-iron cap at the top.

The cylinders for each pier are spaced at 28 ft. 6 ins. centres, and are braced together near the top with a strong lattice girder.



TYPICAL ENGLISH RAILWAY BRIDGE

The cast-iron portions of the cylinders were sunk under air pressure, the steel portions being sent to the site after having been riveted up at the makers' works and then bolted to the cast-iron portions *in situ*. The cylinders were afterwards filled with portland cement concrete, and topped with granite bedstones, which carry the main girders.

The main girders for the centre span are semi-bowstring type, 112 ft. long, by 12 ft. 10 ins. deep centres of intersections at the centre of the girder, and 6 ft. 10 ins. at ends. The side span main girders are Linnville type, 62 ft. 0⅞ in. long by 7 ft. 1 in. deep centres of intersections. The floor of the bridge is composed of single web cross girders. The rail bearers each consist of two continuous R.S. joists, 12 ins. by 6 ins., at 44 lbs., the bridge being covered between the main girders with ⅜ in. flat plate flooring. A walking way is provided along the side of each main girder, with a 12 ins. by 4 ins. bulb angle ballast guard on the line side. Along the inside of the main girders is fixed tubing and standards secured to an 8 ins. by 3 ins. channel, to form the necessary parapet. All the spans are provided with fixed and expansion bearings.

In carrying out the erection, it was found that a temporary timber bridge, which was constructed alongside the site at a somewhat lower level than the new bridge (for the use of the general contractor), could be utilized; therefore, very little temporary staging had to be provided. Each main girder of the centre span was sent from the makers' works in suitable pieces for transit, and assembled and riveted up complete on specially constructed steel bogies, at a temporary siding a short distance from the site, and then pulled on to

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*From "Steel Structures," official quarterly journal of the British Engineers' Association, Steel Structural Section.

the temporary timber bridge parallel to its permanent position, jacked up to its correct level, and slewed into its final place.

The side span main girders were sent from the makers' works riveted up complete, and lifted off the railway wagons on to the temporary bridge by steam cranes. The far side girders had to be slewed into permanent position. The cross girders, rail bearers, and flooring plates were lifted into position by steam cranes.

The total weight of steel, cast iron and cast steelwork in the bridge was about 600 tons.

PROTECTION AGAINST FREEZING*

How Winnipeg's Water Mains, Fire Hydrants and Valves are Taken Care of During the Winter

By T. H. Hooper
Operating Superintendent, Winnipeg Water Works

IMMEDIATELY after use in winter seasons, all hydrants are repacked with a composition of tallow and hemp packing, placed in the stuffing box in hydrant head; otherwise the operating nut would be frozen solid and the hydrant placed out of commission. Occasionally, through a faulty drip, the water will rise in the post, when a steam boiler is used for the purpose of forcing steam into the post to thaw it out.

When a hydrant is found out of repair, the fire brigade is notified, and when placed in commission the brigade is informed. All repairs to hydrants are treated as emergency jobs, and workmen will stay until repairs are completed.

Hydrant repairs are divided into two classes, light and heavy. Light repairs consist of repacking, renewing bolts or nuts, and renewal of parts which can be made without digging out the hydrant. Heavy repairs are occasioned through foreign matter being drawn into the hydrant, such as sticks or stones which have been left in mains at time of construction or the breaking of post or valve.

It is most essential that in laying water mains it should be the duty of some man to inspect each pipe as it is laid, and at night, when men lay off work, to block the end securely to prevent children from throwing stones in the pipes.

Hydrants are placed at approximately 300-ft intervals on all new mains laid, the water works receiving an income from the city at large of $30 per hydrant per annum to offset the water consumed and the maintenance of the hydrants.

Considerable trouble was experienced in past years owing to unauthorized persons operating hydrants, using at times alligator wrenches or large monkey wrenches, and in doing so stripping the edge off the operating nut, which is pentagonal in shape. The writer was successful in having a by-law passed, making it a misdemeanor for any one (except the fire brigade) to use a hydrant without first securing the permission of this department.

There are now in use in Winnipeg 2,360 hydrants and 4,005 valves on domestic service. Valves are inspected the same as hydrants, as it is necessary, in case of a break during a fire to localize the break by shutting off the least possible length of main.

Valve repairs are far more frequent than hydrant repairs, and are caused generally by broken bolts, broken spindles or foreign matter such as sand, stones or sticks blocking the valve so as to prevent it being properly closed when required.

The fire service water works, or high pressure system, which is supplied with water from the Red River, receives the same close attention as the domestic system, there being 158 hydrants and 298 valves.

Water mains in Winnipeg are laid at an average depth of 7 ft. 6 ins., and in spite of the intense cold, frozen mains are almost unknown. Last year a main in an outlying district was found to be so nearly frozen that only a small stream could be secured at the hydrant. The hydrant was left open, when the water gradually cut the ice away.

The only other case the writer remembers was where a 10-in. main was frozen solid. To free this main, it was necessary to make four excavations at a distance of 40 ft. apart; the main was then tapped with 1-in. holes and thawed out with steam from hose inserted in the holes.

If water mains were laid properly in the first place, there would be very few repairs required except in the case of electrolysis.

The writer had occasion recently to cut out some sections of cast-iron water main which had been in service for the past 34 years, when it was found that the pipe and asphaltic covering was in just as good condition as when laid, there being not the slightest trace of wear. Therefore, if joints were properly made and pipe sufficiently tested prior to laying, there would be very little interruption in the distribution system, guaranteeing a full supply when called upon in case of fire.

*Excerpt from paper read at a meeting of the National Fire Protection Association.

COST OF THAWING WATER MAINS

DATA on the 1917-18 experiences of 96 cities with frozen water mains and services are included in the report of a special committee of the New England Water Works Association. The methods employed by these cities in thawing are summarized in the following table:—

	Mains. No. cities.	Services. No. cities.
Electricity	36	31
Steam	8	8
Hot water	4	11
Electricity, hot water	5	24
Electricity, steam	5	6
Electricity, hot water, steam	2	10

One city reported that the blow torch was employed in thawing services; another city employed fire. The cost of thawing with electricity per job varied from $20 to $1. A summary of the costs is as follows:—

No. cities.	Reported cost.	No. cities.	Reported cost.
3	$20	10	$10
1	18	3	$8 to $10
3	$15 to $16	21	$5 to $ 8
3	12	6	$3 to $ 5
2	11	5	Less than $3

The cost of thawing with steam ranged from $4.50 to $75, the later figure being reported by Stamford, Conn. One city reported a cost of $5, one a cost of $17.70, one $20, one $9.41, one $7.63, one $4.50, one $7.50, one $6.50, one $16.50, and one $14.

The reported cost of thawing with hot water ranged from $2 to $20. Four cities reported the cost as being $2. One a cost of $2.67; three a cost of $3; five a cost of $4 to $5; three a cost of $5 to $6; one a cost of $11.20; one $14, one $17 and one $20. One city reported the cost as being 5 cents per foot of pipe thawed.

Three cities reported on the cost of thawing by fire. In one case the cost was $11.16, in another $10.69 and in the third $10 to $30.

Two weeks ago, members of the Dominion government received at Ottawa a delegation of two hundred citizens from North Bay, who urged that a million dollars be spent on improvements to navigation on the French River, which is the first section of the Georgian Bay Canal. They did not receive very much encouragement from the government, as it is not likely that the Georgian Bay Canal work will be undertaken this year unless the unemployment situation demands it, as the Welland Canal, Toronto and St. John harbor improvements, Trent Canal, improvements to St. Lawrence Canals, etc., have first call on the government's funds.

Water Power Resources Conference at Ottawa

Dominion and Provincial Officials In Charge of Water Power Administration Meet With Members of Dominion Power Board and Discuss Co-ordination of Investigations and Administration—Water Resources Index-Inventory Scheme Adopted

TO effect co-ordination of effort and standardization of method in the investigation of water-power resources in Canada, the Dominion Power Board last Thursday and Friday, convened at Ottawa a meeting of representatives of all the Dominion and provincial organizations concerned with the administration of those resources.

Among those who participated in the conference were: R. J. Burley, engineer, Reclamation Service of Canada; E. F. Drake, director, Reclamation Service of Canada; C. O. Foss, chairman, New Brunswick Water Power Commission; T. W. Gibson, Deputy Minister of Crown Lands, Ontario; H. W. Grunsky, legal adviser, Dominion Water Power Branch; J. T. Johnston, assistant superintendent, Dominion Water Power Branch; E. B. Jost, engineer, Department of Railways and Canals; R. S. Kelsch, consulting engineer, Montreal; O. Lefebvre, chief engineer, Quebec Streams Commission; K. H. Smith, engineer, Nova Scotia Water Power Commission; R. G. Swan, chief engineer, British Columbia Hydrometric Survey; Wm. Young, comptroller of Water Rights, British Columbia; and also the following members of the Dominion Power Board:—

Arthur St. Laurent (vice-chairman), Assistant Deputy Minister, Public Works Department; John B. Challies (secretary), superintendent, Dominion Water Power Branch, Department of Interior; H. G. Acres, hydraulic engineer, Hydro-Electric Power Commission of Ontario; Arthur Amos, chief of the Hydraulic Service, Quebec; W. A. Bowden, chief engineer, Department of Railways and Canals; D. B. Dowling, Geological Survey of Canada; B. F. Haanel, chief of Division of Fuels and Testing, Department of Mines; C. N. Monsarrat, consulting engineer, Department of Railways and Canals; and John Murphy, electrical engineer, Department of Railways and Canals.

In the absence of Hon. Arthur Meighen, Minister of Interior and chairman of the Dominion Power Board, the conference was presided over by Arthur St. Laurent, the vice-chairman. A. B. Lambe acted as secretary.

Industry Dependent Upon Power

In opening the conference, Mr. St. Laurent referred to the tremendous efforts of other countries in an endeavor to ensure the production of power in sufficient quantities to meet all needs and upon conditions which would realize the maximum advantageous use of all available sources of energy, especially water power. It was pointed out that industrial activity is dependent upon an available supply of power, and Canada must continue to make the best use of her unique and unrivalled "white coal." The Dominion Power Board hoped to be the medium whereby the experience of the Dominion and provincial organizations concerned with power problems would be consolidated and co-ordinated, and their activities concentrated upon such action as would be necessary to assure Canada her proper place in the reconstruction period.

Future Prosperity Ensured

The great fuel reserves of Canada and her fortunately located water-power resources, if thoroughly investigated, properly exploited and adequately developed, form an industrial asset which, probably more than any other, will ensure for the Dominion a full measure of future prosperity.

As indicative of the extent and availability of the water-power resources of the Dominion and of the remarkable degree to which their adaptability for central electric station work has been appreciated in principle and realized in practice, Mr. St. Laurent referred to the following important facts disclosed within the last few days by the completion of a census of the central electric-power station industry in the Dominion, the census having been undertaken by the Dominion Bureau of Statistics in co-operation with the Dominion Water Power Branch:—

Census of Central Stations

Out of a total installed primary capacity of 1,844,571 h.p., 1,652,661 h.p., or practically 90 per cent., is derived from water.

The capital actually invested in the central electric stations industry total $356,004,168, of which 79.5 per cent. is invested in commercial stations and 20.5 per cent. in municipal or publicly-owned stations.

The total employees connected with the industry, including officers and wage earners, numbers 8,847, of which 58 per cent. are connected with commercial, and 42 per cent. with municipal stations. The salaries and wages paid to these employees totals $7,777,715 per annum.

The total revenue received from the sale of electrical energy is $44,536,848, of which $29,135,399 was secured by commercial and $15,401,449 by municipal plants.

The water power used in central station work in Canada averages 198 installed horse-power per thousand population. In the United States in 1912, water power installation in central station work averaged 24.7 h.p. per capita.

The above figures have reference solely to the central stations themselves and wholly exclude all allied or dependent industries such as electric railways, electro-chemical industry, pulp and paper plants and all other industries of interests using electric energy directly or indirectly.

Subjects Discussed

The subject matters of the conference, which were of the greatest general interest, included a "Water Resources Index-Inventory" system for all of Canada; co-ordination of investigating efforts; the prompt publication of the results of hydrometric surveys; extension of the Meteorological Service to secure all the data necessary for reclamation, irrigation and drainage, and for the consideration of water-power problems; co-ordination of water-power administration in the various Dominion and provincial jurisdictions.

Water Resources Index-Inventory

Owing to the great area of the Dominion and the fact that both Dominion and provincial authorities have for years been concentrating their efforts upon the solution of various and frequently conflicting phases of water resources problems, a lack of uniformity exists in the method of recording and analysing essential pertinent data.

The need is therefore apparent for a uniform and co-ordinated system of recording, filing and analysing water resources data—a system that will be equally adaptable to Dominion and provincial requirements. The conference adopted a system known as the "Water Resources Index-Inventory," perfected by the Dominion Water Power Branch and recommended by the Dominion Power Board.

The scheme is said to be flexible and simple and well suited for general adaptation, not only by governmental organizations and interested corporations, but by all engineers who are concerned with the collation and consideration of water resources information. *The Canadian Engineer* has arranged to have a full explanation of the scheme appear in an early issue.

Hydrometric Surveys

All the members of the conference were in thorough accord with the Dominion Power Board as to the necessity for co-ordination of effort and the standardization of methods in hydrometric survey work generally. There are now over twelve Dominion and provincial organizations concerned with

securing hydrometric survey data. There is great diversity, not only in the methods employed, but also in the manner of making the results generally available.

In the central portions of the Dominion, where such data is of particular importance, and where it is necessary to have it made available as promptly as possible after the completion of the field work, there is considerable confusion. In order to work out a definite policy for the co-ordination of effort in field work, to ensure that all parts of the Dominion are properly and thoroughly covered, and to work out some method of collaboration and co-operation in the publication of the data, it was decided that there should be convened, as soon as possible, conferences of representatives of all the organizations concerned.

It is consequently proposed to hold a conference at some convenient point in Western Canada, probably during the summer months, of representatives of all organizations interested in hydrometric survey work in the provinces of British Columbia, Alberta, Saskatchewan and Manitoba.

It is also proposed to hold a similar conference in Eastern Canada of representatives of the various organizations concerned with hydrometric work in the provinces of Ontario, Quebec, New Brunswick and Nova Scotia.

Following these territorial conferences there will be a final meeting at Ottawa, under the auspices of the Dominion Power Board, as a result of which there can be worked out for the whole of Canada a definite scheme of hydrometric work which will provide not only for the general standardization of field and office practice, but also for some system that will correlate the work of all organizations, avoid duplication of effort, and promote efficiency and economy.

Water Power Administration

Extended consideration was given to the various systems of administration and the different schemes of water-power regulation in force in Canada.

While there is much diversity in the methods of water-power administration now in vogue for the different provinces, there is—apart from fundamental differences of policy between public-ownership operation in Ontario and the development by private initiative (under government control) in the other provinces of the Dominion—sufficient similarity in the fundamental principles of administration to afford a great field for collaboration, for mutual advice and assistance, and possibly for co-operation in perfecting a more or less standardized practice respecting such important matters as nature and term of franchise, rentals, control of rates, recapture provisions, determination of franchise, etc.

After a free interchange of ideas and full explanation of present practice in the different jurisdictions, those attending the conference were unprepared to suggest the adoption for all parts of Canada of a uniform plan, or technique, for water-power administration, but were able to sketch in a preliminary way the general philosophy which should lie behind all such administration.

To facilitate the consolidation of the experience, research and efforts of the different Dominion and provincial administrative authorities, it was unanimously agreed that regular annual conferences should be convened in Ottawa, under the auspices of the Dominion Power Board.

At the annual meeting of the Winnipeg Builders' Exchange, held December 27th at the Fort Garry Hotel, H. T. Hazelton was re-elected president; John Sutherland, first vice-president; N. W. Warren, second vice-president; T. D. Robinson, treasurer; and J. S. Hooper, secretary.

Arrangements have been made by the Imperial Oil Ltd., to insure the lives of all the employees who have been with the company for one year or longer. The maximum is $2,000. On February 1st a plan of old age pensions will also become effective and on March 1st a scheme for health insurance. All of these are to be managed by a committee of employees under the direction of the Board of Directors of the company. No medical examination will be required for the insurance, and the entire expense of the various schemes is to be borne by the company.

BROOKLYN ARMY SUPPLY BASE

Largest of Six Terminal Storage and Ship-Loading Plants Erected by the United States Government

OF a number of terminal storage plants now being built or completed on the Atlantic Seaboard for the accumulation and shipping of supplies to the American Expeditionary Forces in France, the largest is the Army Supply Base at Brooklyn, N.Y.

The extraordinary quantity of supplies necessary to maintain the overseas forces, together with the scarcity of shipping, necessitated the provision of supply reservoirs to absorb shipments and prevent congestion at tide-water. Boston, New York, Philadelphia, Baltimore, Norfolk, Charleston, and New Orleans were selected as points for the construction of the Army Supply Bases on the Atlantic Coast, and there were a large number of supply depots also established at points in the interior.

The Army Supply Base at Brooklyn is between Second Avenue and the pier-head line, and extends from 58th to 64th Street with an addition to 65th Street between Second and Fourth Avenues. Including the land under water, 100 acres have been acquired. In accord with the general policy of the United States government, the land was acquired in fee and permanent buildings were constructed.

The Brooklyn Base consists essentially of two reinforced concrete warehouses of the most modern construction, three large covered piers, one uncovered or lighterage pier, power house, administration building, machine shop, garages, etc., with the necessary railroad tracks, storage yards, trucking areas, etc.

The layout provides an extremely elastic plant for storage and shipping. Berths are provided for twenty average-size, ocean-going ships, which may be loaded direct from railroad cars or from the accumulated storage in the buildings with equal facility.

Two Huge Warehouses

Storage battery trucks and trailers are used in transferring supplies from buildings to piers and from point to point in the buildings. A feature worthy of note is the two-level provision for moving supplies from the buildings to the ships, and *vice versa*. The first deck of the piers, the "farm" area, the dock story of Warehouse "A," the tunnels between Warehouses "A" and "B," and the basement of Warehouse "B" are all one level. At an elevation 28 ft. above this, the second deck of the piers, the bridges to Warehouse "A," the third stories of the warehouses, and the bridges between them, provide an entirely separate traffic level, and the elevators in the buildings and on the piers provide flexibility of transfer from one level to another.

The two warehouses, known as "A" and "B," are west and east of First Avenue, respectively, and extend from 59th to 63rd Street. Each is 980 ft. long and eight stories high, with basement. Warehouse "A" is 200 ft. wide, and Warehouse "B" has a total width of 306 ft., and is built with an interior court, 66 ft. by 700 ft., in which two electrically operated cranes will transfer materials from the unloading platforms to the various floors.

Except that it has no court, Warehouse "A" is similar in all features to Warehouse "B." Both buildings are of the flat slab type of reinforced concrete construction, with circular columns 20 ft. from centre to centre, except around the elevators. The first three floors are designed for a 300-lb. live load, and the upper floors for a 250-lb. load. A modern sprinkler system is provided throughout, and heat from a central heating plant in the power house is designed to keep the temperature above 48° at all times.

The northerly third of Warehouse "B" is founded on Raymond concrete piles. Warehouse "A" and the administration building are on spread footings, and the power house is on wooden piles cut off at low water. Wherever spread footings were used, the soil was a firm sandy loam, providing excellent foundation.

The water front development consists of a bulkhead wall extending along the full front of the property 1,350 ft., and three covered piers 150 ft. wide and about 1,300 ft.

long, and one uncovered or lighterage pier, 60 ft. wide and of the same length. The three slips between these four piers are 200 and 250 ft. wide, and have been dredged to a depth of 35 ft. at low water. An additional depth of 5 ft. in one of the slips is under advisement.

The three covered piers are identical in construction and dimensions, except for a slight increase in length from north to south to conform to the pier head line; the three pier sheds, however, are of the same length. The piers are founded on untreated wooden piles, from 40 to 65 ft. long, driven by a water jet in the sand and gravel formation.

Bents are 10 ft. from centre to centre, and, in general, the piles are 5 ft. from centre to centre in the bents, except under the railroad tracks and the shed column footings, where they are closer. The piles are cut off above high water, and are capped by 12 by 12-in. wooden timbers which support a 10½-in. reinforced concrete deck.

Two standard gauge railroad tracks occupy the centre of the pier for its full length, and under these the slab is increased to 15 ins. in depth. Pile spacing and slabs are designed to carry a 500-lb. live load on the first deck and a 300-lb. load on the second deck of the pied shed.

The shed columns are founded on concrete footings supported on pile clusters, cut off at half tide and capped with 12-in. timbers on which a 4-in. plank platform is laid to receive the concrete. These footings are 20 ft. from centre to centre, longitudinally, and approximately 46 ft. transversely, the outside line of footings being about 5 ft. from the edge of the pier.

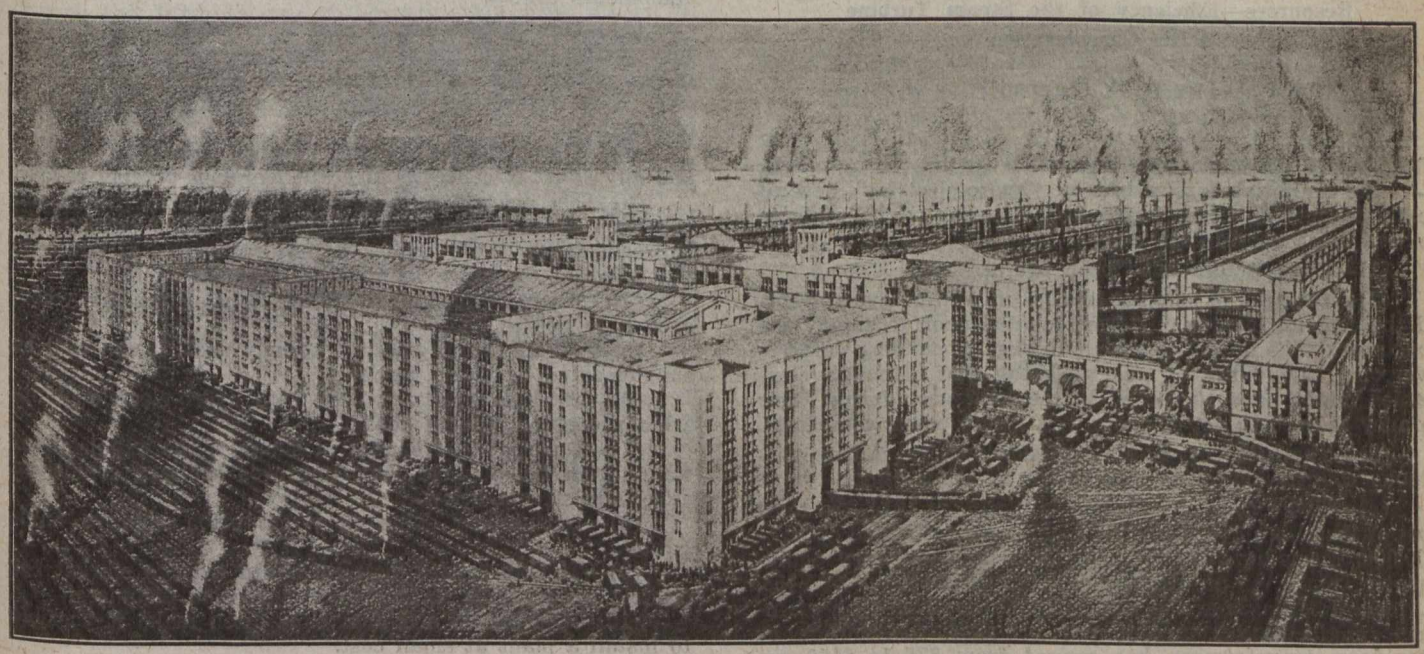
The pier shed consists of a double-deck steel structure, with a timber roof covered with 5-ply felt and slag roofing. The second deck, which is 28 ft. above the first, is a beam and slab construction of reinforced concrete with a granolithic finish troweled smooth, supported on brackets riveted to the main transverse trusses. A steel cargo beam and walkway is provided for whatever freight-handling devices may be erected subsequently, and provision is made for twelve large freight handling-elevators, of which six are to be put in at this time. Double-leaf, vertical-lift, folding doors are provided for the sixty-one openings between columns on each side of the pier, on both the upper and lower decks.

The bulkhead, which runs along the whole water front length of the property, is of the usual platform type founded on wooden piles cut off at low water and capped with 12 by 12-in timbers. The pile bents are 4 ft. from centre to centre, and the piles are 4 ft. apart in the bent. The platform is 24 ft. wide.

A concrete wall, of gravity section, is built in the front of the platform, with its top 10½ ft. above M.L.W. To provide easy access to the piers from Warehouse "A," a 4-span steel truss bridge, with a reinforced concrete deck, is to be built from each pier to the warehouse. The floor of the bridge is at the elevation of the second deck of the pier and enters the warehouse at the third-floor level. The roof and sides of the bridge housing are of reinforced concrete, with glazed sash—at intervals—along the sides.

The "farm" area, between Warehouse "A" and the bulkhead, as well as certain other areas in and around the buildings, will be paved with bitulithic pavement laid on a concrete sub-base. The first deck of the piers and certain trucking areas in the buildings are to be paved with asphalt blocks with sand-filled joints.

The whole project has been under the sole authority of the Construction Division of the United States Army in all matters pertaining to the design, engineering and letting of contracts and the supervision of building operations. The designs were made and the work carried out by an architect and general contractor whose work was subject in all respects to the approval of the Constructing Quartermaster.



THIS U.S. ARMY SUPPLY BASE HAS ABOUT 4,000,000 SQ. FT. FLOOR AREA IN ITS TWO MAIN BUILDINGS, 20 MILES OF RAILWAY TRACKS AND 4 BIG PIERS—COST TO DATE, $32,500,000

On April 6th, 1918, the general requirements for the Base were laid down by Gen. George W. Goethals, Director of Storage and Traffic; on April 27th, the Secretary of War authorized construction, and on the same date H. S. Crocker, Lieutenant-Colonel, Quartermaster Corps, was ordered to proceed to the site to take charge of the construction as Constructing Quartermaster. On May 6th, the initial allotment of $32,500,000 was made for the cost of the project, including the site. There have been no subsequent allotments.

The Constructing Quartermaster formally took over the site on May 17th, 1918. Work, however, had begun on May 15th, by starting a steam shovel on the excavation for Warehouse "B." The driving of Raymond concrete piles was begun under Warehouse "B," north end, on May 18th, and finished on July 8th, 5,829 piles having been driven in 43 working days.

The concreting of the footings was begun June 1st; the first concrete in the superstructure was poured on July 3rd, and all buildings were under roof on September 26th, within which time 183,173 cu. yds. of concrete were poured in the two warehouses. This corresponds to an average day's run of 1,926 cu. yds., with a maximum of 4,500 cu. yds., both per 10-hour day. The dredging in the slips was begun on June 22nd, and has progressed at the rate of about 10,000 cu. yds. per 24-hour day. Pile driving on the piers was begun on July 25th. The following table shows the quantities of the

principal materials used in the project, from which can be gained an idea of the size of the development:—

Excavation, 644,000 cu. yds.; dredging, 1,750,000 cu. yds.; gross floor area, 5,085,000 sq. ft.; concrete, 250,900 cu. yds.; reinforcing steel, 16,310 tons; concrete piles, 87,000 lin. ft.; wooden piles, 1,621,500 lin. ft.; timber, 3,000 M.b.m.; structural steel, 10,100 tons; steel sash, 261,300 sq. ft.; piping and conduit, 240 miles; paving, 61,000 sq. yds.; railroad trackage, 20 miles.

The general contract for the construction of the whole project was let to the Turner Construction Co., New York. A total of sixty-one sub-contracts have been let for the incidental work in connection with the project. The architect was Cass Gilbert, New York.

FACTORS RETARDING WATER-POWER DEVELOPMENT

And the Advantages Gained by Utilizing Available Water Resources—Efficiency of the Steam Turbine a Big Consideration

By D. H. Colcord
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

CERTAIN economic and legislative factors have taught the uninitiated investor in "hydro-electrics" several costly lessons in recent years, and it seems worth while to review these considerations:—

(1)—Load-factors have been overestimated.

(2)—Drought in summer and ice in winter have prevented the constant source of power counted upon to supply the consumer. The initial cost for building impounding dams to overcome this difficulty was so great that although companies might have succeeded in the long run, during their infancy they could not compete with steam power companies.

(3)—The high cost of transmission systems in a mountainous country has been prohibitive in some degree.

(4)—The cost of installation is high. In 1914, the total cost of installing hydro-electric plants was estimated at $27,000,000, including distribution systems and auxiliary equipment. This gives an average cost per horse-power of $158. A general estimate of the cost complete as given by a prominent engineering company, not including distribution or step-down transformers, has ranged from $75 to $150 per kilowatt installed. If the price of coal increases, in time it will compare favorably. At least the marginal difference in cost will demand increased efficiency in the operation of hydro-electric plants which might make up for this difference. The best steam practice secures at the electric generator less than 20 per cent. of the energy stored in coal, while the efficiency of the water wheel frequently exceeds 90 per cent., which is worth considering.

(5)—The rapid development of the steam turbine, with its increased efficiency, has discouraged water power.

(6)—Distance from the market has been a factor.

(7)—The high value of land in industrial districts has restricted development.

(8)—Railroads have followed the streams and in many instances would have to be rebuilt.

(9)—Many of the streams are of an interstate, interprovincial, or international character, involving legislative difficulties.

(10)—The fact that several projects have been started and abandoned has had a bad moral influence.

(11)—Long-term franchises held by municipal heating and lighting companies made competition impossible.

(12)—The forestry laws contain inadequate provisions for the leasing of land.

(13)—There is a scarcity of real good head sites.

(14)—There is not enough data available on the geological features of stream beds.

(15)—The recent scarcity and high cost of labor and building material has prevented, since the war, even the completion of developments already started.

The 1916 report of the Pennsylvania Water Commission contains data on hydro-electric projects that have been started and dropped for various reasons, as follows:—

(*a*)—Projects were begun at a time when there was a marked scarcity of capital.

(*b*)—The companies failed to realize the necessity for a complete engineering survey. Improper sites were chosen and then abandoned.

(*c*)—Hydrographic conditions were overestimated and in some cases there was not as much water available as counted upon.

(*d*)—Commercial surveys were not thorough in all cases and companies in some cases overestimated their markets for power.

(*e*)—In three instances uncertainty in regard to the legal rights possessed by the companies, and subsequent legislation, blocked their progress.

(*f*)—In several projects, the blame for failure can be laid at the door of financial misfortune.

The general advantages derived from water-power developments are:—

(1)—The highest use of coal is to create heat to preserve man's life and the term of man's existence may depend on the care of the supply. Fuel is not essentially reproductive. Water-power for industry can save millions of tons of coal a year.

(2)—The industrial section depends primarily on fuel and any effort to conserve fuel will lengthen productive life.

(3)—The electrification of all railroads is inevitable and provision must be made to supply the electric power. As railroads follow the streams, the natural source of power is that which is the most available—the stream itself.

(4)—Water power makes electric lighting possible wherever it is needed.

(5)—Where steam power is already used, it can well be supplemented by water power.

(6)—Storage reservoirs used with hydro-electric plants are a protection against floods.

(7)—During the droughts in summer, the expulsion of water from impounding dams improves sanitary conditions along the stream below.

(8)—Impounding dams on rivers often improve navigation.

(9)—Thickly settled districts afford a large market for electric power, with reasonable transmission distances.

(10)—Old canals and dam sites often make it possible to install a plant at small cost.

(11)—There are many limestone streams in mountainous districts that have a high rate of flow during the dry seasons.

(12)—Labor released by the winning of the war can be used to build the plants.

(13)—Increased industrial efficiency is effected, due to labor saving and waste prevention in distributing power.

From a conservative and absolutely safe standpoint, considering immediate returns on the investment, the correct policy is to use water power only to supplement steam where coal is available at a fair price. But this policy is somewhat pinched and near-sighted from national, industrial and economic standpoints, because the time is coming when the available coal will be gone. There may come a time when the coal that is left will be required for purposes that a central station cannot serve, such as driving the engines on our ocean liners, or as fuel for keeping us warm.

In Great Britain, proposals have been set forth for vast central station power plants, and stock is being taken of all of the water powers of the British Isles. Since the outbreak of the war, the Italian government has proceeded with an active water-power policy. In 1917 and 1918 there have been concessions granted for 1,024,000 horse-power. Norway has developed 1,120,000 turbine horse-power and plans to export hydro-electric power to Denmark. Barcelona, in Spain, is replacing steam power by hydro-electricity. In Switzerland, 25 per cent. of the 2,000,000 available horse-power has been developed. A Canadian company has completed a large portion of an extensive system of reservoirs and hydro-electric stations on the Nogurea Pallareasa and Segre Rivers. All this is indicative of the fact that people are laying a lasting foundation for power for years to come.

RECONSTRUCTIVE CONVALESCENCE

Necessary to Heal the Wounds of War, Says the American Society of Civil Engineers

AT the annual meeting of the American Society of Civil Engineers, held last week in New York City, the following resolution was adopted:—

"Whereas, the wounds of war from which our country is now suffering cannot be healed except through a period of reconstructive convalescence; and

"Whereas, the only means for hastening and bringing such convalescence to the earliest and most satisfactory conclusion is to be found in the prescription of *work and the opportunity of work for every individual*, and as, in the absence of such opportunity, it is inevitable that daily wages earned will be replaced by the ministrations of charity; now, therefore, be it

"Resolved, that the American Society of Civil Engineers as represented by its members present at its Annual Meeting on this fifteenth day of January, 1919, does pledge its undivided, collective and individual effort and influence toward the end of advocating an immediate beginning and rapid prosecution of all necessary public and private works and undertakings; and be it further

"Resolved, that it is the sense of this meeting that RECONSTRUCTION is synonymous with RESUMPTION; that those considerations as to the cost of work which have heretofore been held as fundamental must NOW be viewed in the light of present conditions; that due emphasis must be given to the absolute dependence of all classes upon their current employment and that the necessity of providing an abundance of useful occupation rests as a paramount duty upon those who direct every class of effort, whether public, private or governmental."

Copies of this resolution were mailed to all technical societies of the United States and Canada; to the President of the United States; to all members of congress; to all cabinet, departmental, executive and administrative officers of the United States government; to the governors of all the states; to all state engineers; to the mayors of all cities and towns of the United States having a population of over 30,000; to the Federal Reserve Bank at Washington, with the request that it be forwarded to the several districts of the Federal Reserve Bank with the request that each district bank transmit the same to all national banks and other financial institutions which are members of the Federal Reserve system; to the National Bankers' Association, with the request that it be brought to the attention of the members of that association; to the technical and other press; and to chambers of commerce and other civic organizations of two hundred of the largest cities and towns in the United States.

ANNUAL MEETING, AM.SOC.C.E.

MEMBERS of the American Society of Civil Engineers, from many parts of the United States and Canada, assembled at New York Wednesday and Thursday of last week for the sixty-first annual meeting of the society. A business meeting was called to order at 10 o'clock Wednesday morning, adjourning at 1 p.m. for luncheon, and meeting again at 3 p.m. to hear an address by Brig.-Gen. R. C. Marshall, Jr. At 9 p.m., there was the president's reception, with dancing, at Hotel Biltmore.

The following day was spent in an excursion to the Brooklyn Army Supply Base and to the Newark Bay Shipyard of the Submarine Boat Corporation. At 8 p.m., Thursday, there was an address by Brig.-Gen. S. T. Ansell, followed by an informal smoker.

The business meetings were held in the auditorium of the United Engineering Societies' building. On the excursion, luncheon was served by the Turner Construction Co., who are the general contractors for the Brooklyn Army Supply Base, a brief description of which appears on another page of this issue.

ANNUAL MEETING, TORONTO BUILDERS' EXCHANGE

OFFICERS for the ensuing year were elected at the annual meeting of the Toronto Builders' Exchange held last Monday afternoon, but practically no other business was transacted, the meeting being adjourned until 3 p.m. next Monday, when the exchange will consider the proposal that it should merge with the newly formed Association of Canadian Building and Construction Industries.

W. E. Dillion, who has been president of the exchange for the past year, was in the chair and was urged to accept the presidency for another year by acclamation, but Mr. Dillon refused to consider it. Walter Davidson, who was first vice-president last year, also refused the presidency, stating that he would be too busy this year to give proper attention to the office. The elections then resulted as follows:—

President, A. D. Grant, of A. D. Grant and Co.; first vice-president, Walter Davidson, of Walter Davidson and Co.; second vice-president, A. H. Dancy, of H. N. Dancy and Son; treasurer, John Aldridge, of Aldridge and Son; secretary, D. J. Davidge.

PROGRAMME OF MEETINGS, MONTREAL BRANCH ENGINEERING INSTITUTE OF CANADA

DURING the season, January to April, 1919, the Montreal Branch of the Engineering Institute of Canada proposes to hold a meeting at 8.15 o'clock every Thursday evening with the exception of February 13th, which is the date of the annual professional meeting in Ottawa.

Last Thursday evening B. O. Eriksen and S. H. Deubelbeiss read a paper on the "Design and Construction of Reinforced Concrete Viaducts"; and W. F. Chipman, K.C., discussed "Some Problems of National Reconstruction." This evening J. A. Burnett will lecture on "Coaling Plant for Locomotives"; and George K. McDougall, on "Industrial Illumination."

Following is the programme for the remainder of the season:—

Jan. 30th,—Coal Briquetting, by Paul Seurot; Coal is King, a motion picture by the R. E. Cleaton Co.

Feb. 6th,—Some problems in Ocean Transportation, by A. W. Robinson; Manufacture of Nitro-Benzol and Aniline Oils, by G. J. Caron.

Feb. 20th,—Construction of Canadian Northern Railway Tunnel, Montreal, by J. L. Busfield.

Feb. 27th,—The Effect of Ice on Hydro-Electric Plants, by R. M. Wilson.

March 6th,—Air Drills, by N. M. Campbell; The Halifax Explosion from a Chemist's and Physicist's Viewpoint, by Dr. Howard Bronson; Burroughs Adding Machines, a motion picture by the Burroughs Adding Machine Co.

March 13th,—Electrical Welding, by C. V. Holslag; Patents and Engineering, by Hanbury A. Budden.

March 20th,—Ball Bearing Jacks, by W. H. C. Mussen; Peat, by Ernest V. Moore.

March 27,—Some Notes on the Design and Construction of Reinforced Concrete Covered Reservoirs, by R. deL. French.

April 3rd,—The Operation of Railways as an Engineering Problem, by V. I. Smart.

April 10th,—Waterproof Paper Productions and their Industrial Possibilities, by J. A. DeCew.

April 17th, Quebec Bridge, by Phelps Johnson, G. H. Duggan and George F. Porter.

April 24th,—Continuation of Quebec Bridge Lectures.

Walter J. Francis is chairman for the season; Arthur Surveyer, vice-chairman; Frederick B. Brown, secretary-treasurer. The following are the members of the executive committee:—

F. P. Shearwood, H. G. Hunter, O. O. Lefebvre, W. Chase Thomson, J. G. Papineau and K. B. Thornton.

R. M. Hannaford is chairman of the Papers and Meetings Committee. The officials of the Industrial Section are S. F. Rutherford and H. G. Hunter; Electrical Section, J. A. Shaw and A. Frigon; Mechanical Section, J. T. Farmer and J. A. Burnett; Civil Section, J. Duchastel and H. M. Lamb.

FIRE PREVENTION

AN illustrated lecture on "Fire Prevention" was given before the Engineering Institute of Canada, Montreal Branch, January 9th, by George H. Greenfield, fire prevention and safety engineer, Canadian Car and Foundry Co. The speaker explained the elaborate methods of inspection that his company has developed, and showed views of deluge sets that the company has adopted to deal with possible fires in its lumber yards.

The system of fire protection drawings that has been adopted was outlined. These drawings are framed and posted around the works. They feature the water main system and various control valves, so that in case of need, reference information is instantly available.

Mr. Greenfield asserted that in his opinion a large number of fires in this country have resulted from accumulations of various classes of material and garbage, some of which is susceptible to spontaneous combustion.

JOINT COMMITTEE TO DRAFT LICENSE BILL

MEMBERS of the Ohio Engineering Society have voted unanimously in favor of the principle of licensing engineers. It is expected that a bill will be presented to the state legislature at its present session. President Clyde T. Morris, of the Association of Ohio Technical Societies, announced a plan for study of the subject by all engineering organizations of Ohio, in order that a generally acceptable bill may be drafted. He has called upon all the societies composing the Ohio Association to name committees on licensing, and a conference of these committees will be called at Columbus in the near future for discussion and drafting of the bill.

The Indiana members of the American Association of Engineers will meet jointly with the members of other engineering societies this evening at Indianapolis, to organize support for the Indiana engineers' license law.

Nominations of the American Water Works Association for the year 1919-20 are as follows: President, Carleton E. Davis, Philadelphia; vice-president, M. L. Worrell, Meridan, Miss.; treasurer, J. M. Caird, Troy, N.Y. J. M. Diven, of Troy, is secretary.

Imperial Oil, Ltd., is taking steps to promote friendly relations between the firm and the employees and to advance their mutual welfare by the inauguration of the so-called trade parliaments, such as have been established in Great Britain. Briefly, the plan is this: The employees will elect by free and secret ballot, workingmen's committees, representing the many trades that enter into the oil industry, in numerical proportion, one delegate for every 75 employees being the scale adopted. These delegates will sit jointly with an equal number of officials, appointed by the company, and will deal with all grievances, questions of wage increases and plans for the betterment of social conditions.

A big steel merger for export trade has recently been effected in the United States. The North American Steel Products Corporation has been organized, representing the following companies, with a combined annual ingot capacity of 12,000,000 tons: Bethlehem Steel, Brier Hill Steel, Lackawanna Steel, Lukens Steel, Midvale Steel and Ordnance, Republic Iron and Steel, Sharon Steel Hoop, Trumbell Steel, Whitaker-Glessner and Youngstown Sheet and Tube Companies. E. A. S. Clarke, president of the Lackawanna Steel Co., will be president of the new corporation, having resigned from his present position. It is expected that other producing interests will join the North American company later, and that eventually it will represent in export trade practically all steel-producing companies of the United States, with the exception of the United States Steel Corporation, which has its own subsidiary export company. In addition to its proposed principal office in New York City, the new concern will have branches throughout the world wherever the introduction or sale of American iron and steel products seems desirable.

WHAT AQUEDUCT REPORT WILL COVER

WHEN engineers are appointed by the city commissioners of Montreal to report on the proposed completion of the aqueduct enlargement, they will be asked to consider the best method of using the canal to supplement the domestic water supply of the city, at the same time conserving its water-power capacity.

The engineers will also be requested to make a study of the general scheme of water distribution throughout the city, and to report on sufficient reservoir capacity, which is lacking at present.

The commissioners state that no complete study has yet been made of the aqueduct; that the water situation is likely to become acute this summer, as the conduit which supplies the city with water is taxed nearly to its full capacity and the demands may soon exceed the capacity; that the aqueduct has caused a great deal of discussion among engineers; and that it is therefore advisable to obtain disinterested reports from engineers who have not previously been associated with any of the discussions. At the request of the commissioners, the city council has voted $25,000 to cover the expense of the report.

The annual meeting of the Montreal Builders' Exchange will be held next Monday.

The net expenditure of the American Society of Civil Engineers for publishing its proceedings, transactions and year book during the year 1918 was $35,350.

During the year 1918, the American Society of Civil Engineers elected 537 new members and lost 109 dead, 44 resigned and 41 dropped from the roll; a net gain of 343 members. The membership of the society now totals 8,933, of whom 1,471 are resident in the New York district.

A. W. Campbell, highways commissioner for the Dominion government, and W. A. McLean, deputy minister of highways for Ontario, will deliver addresses at the first annual meeting of the Eastern Ontario Good Roads Association, to be held on February 4th and 5th in Ottawa. The association has applied for provincial incorporation.

The Engineering Council, representing the four leading engineering societies of the United States has asked the Board of Apportionment of the city of New York to reconsider its action of December 30th, 1918, whereby it reduced salary appropriations to such an extent as to necessitate the discharge by the Public Service Commission of 339 men employed in engineering work on the construction of subways. The Council asks the Board to make an appropriation that will enable the Commission to effect, safely and economically, the rapid completion of the subway work. It also asks the Board to leave to the Commission, on which the law places the responsibility, the detailed apportionment of the appropriation in accordance with a practical schedule to be prepared by the Commission and to be submitted to the Board "for the Board's information."

According to the report of the secretary of the American Society of Civil Engineers for the year 1918, if all of the bills incurred during that year had had to be paid by the end of that year, the books of the society would have shown a deficit of more than $20,000. The annual cost of the society's present quarters in the United Engineering Societies' building is said to be greater than was the cost of their own building on 57th St., although the latter afforded more room. In addition, co-operation in the Joint Library increased the annual expenditures by at least $5,000. The cost of the three stories which were added to the United Engineering Societies' building to accommodate the society was over $40,000 greater than had been estimated. Inability to rent their former building, and remission of fees due to the war, complicated the situation. Altogether, there was an unexpected expenditure during the year, including remissions of dues, amounting to $98,000. Unfortunately, it was necessary for the society to borrow money temporarily to meet its ordinary expenses and pay roll. Regardless of these seemingly adverse figures, however, the society appears to be in a healthy financial condition, having assets of $1,265,891, and a surplus of assets over liabilities amounting to $965,576.

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PRINCIPAL CONTENTS

THE CANADIAN MINING INSTITUTE

THREE councillors of the Canadian Mining Institute, and also three other members of that Institute, have written letters to the editor of the Institute's "Bulletin," criticizing the editorial in "The Canadian Mining Journal" for November 1st and the editorial in *The Canadian Engineer* for November 7th. Both of these editorials dealt with the status of the Canadian Mining Institute.

With the criticism of "The Canadian Mining Journal," we are naturally not concerned; but in regard to the editorial in our own paper, we would most respectfully point out to these six members of the Canadian Mining Institute that there was not and is not the slightest desire or intention on the part of this paper to say anything derogatory about the Canadian Mining Institute.

To the contrary, *The Canadian Engineer* has always had a very high respect for the work of the Canadian Mining Institute, and that respect has received expression in these columns upon frequent occasions.

It is quite evident that some of these six men had not read the editorial in *The Canadian Engineer* for November 7th with any great amount of care, as some of the letters attribute to that editorial, statements that did not appear at all in the editorial, and they also make an effort to read into the editorial, intimations and motives that were entirely lacking.

The whole *raison d'etre* of the editorial on the Canadian Mining Institute in our issue of November 7th was merely that we had observed an editorial of a rather unexpected nature in "The Canadian Mining Journal," and we expressed wonder as to whether the Canadian Mining Institute would be willing to endorse those editorial statements made by "The Canadian Mining Journal." The editorial in our paper consisted almost wholly of quotations from "The Canadian Mining Journal," with very little comment by us, and certainly none of a nature derogatory to the Canadian Mining Institute; this fact has been unfortunately overlooked by some of the six men mentioned above, although the quotations were carefully placed within quotation marks. Regardless of this fact, some of these six men deal with the matter as if all the statements in our editorial, whether inside or outside of quotation marks, had been made by *The Canadian Engineer.*

It is true that the introduction to our editorial was based upon the remarks made a few years ago by Prof. Haultain, which remarks appeared to be thoroughly borne out by the editorial in "The Canadian Mining Journal," but it was clearly stated that "we wonder whether the Canadian Mining Institute would officially endorse this admission" (that is, the admission made by Prof. Haultain and "The Canadian Mining Journal"). So far as six prominent members of the Canadian Mining Institute are concerned, we have received our answer. Those members, at least, apparently are not prepared to endorse the statements of Prof. Haultain and "The Canadian Mining Journal."

THE POWER BOARD'S CONFERENCE

CANADA is in better position than any other country to enjoy the advantages resulting from the development and use of water-powers. Moreover, the best available information shows that at present Canada has more satisfactory general and basic data respecting water power resources than has any other English-speaking country at least, and possibly as much as has any nation of equally vast territory.

But there has long been needed some central organization to act as a clearing-house of information and as a medium of co-ordination both in administrative and investigatory work. The Dominion Power Board, appointed last year by the government, appeared to be the logical medium, but, as pointed out some weeks ago in these columns, no information had yet been made public regarding the investigations and plans of that Board, so the public was not able to judge whether that body would rise to its opportunities for national service. We are glad to note that the Board has now decided to give full publicity to its work, beginning with the minutes of the two-day conference of Dominion and provincial authorities held last week at Ottawa under the Board's auspices.

Judging from the report of that conference, there is every reason for the public to expect good work by the Board. The conference, apparently, was successful and will lead to most useful and important results. It should give a stimulus to the urgently needed co-ordination of energy resources of all kinds. It has at least cleared the air nicely in regard to preliminaries, and will lead, we hope, to better team work and more rapid progress in developing our "white coal" and conserving our fuel for work in which it will be indispensable in years to come.

In the past there have been a lack of cohesion and a duplication of effort and expenditure by the various organizations that were represented at last week's conference. This has been pardonable and, in fact, at times has been beneficial in encouraging competitive ability. But the war and its consequences have brought us face to face with the need for a more serious consideration of economic problems, and the stimulus of competitive effort should no longer be needed to so great an extent as formerly. There are now more or less efficient and effective administrative and investigatory systems covering practically all parts of Canada. Their work should be continued under the master control of some central body, like the Dominion Power Board, which should be given authority, staff and funds sufficient to enable it to insist upon all Canadian energy resources being utilized in the best interests of the nation, present and future, and to safeguard private rights from any unfair onus due to its commands. With such a Board aggressively at work and supported by proper legislation, there would be no fear for the future of the energy resources of this country.

In view of the diverse and fundamentally important matters requiring co-operation by the various Dominion and

provincial water-power organizations, it is unfortunate that such a "get-together" meeting was not convened years ago. It is pleasing to note that further conferences of this sort are to be held soon, as it is apparent that consolidation of experience and co-ordination of effort are essential to the economical and consistent exploitation of Canada's energy resources.

DEATH OF COL. R. S. LOW

COL. Robert Smith Low, general manager of Bate, McMahon and Co., Ltd., contractors, Ottawa, died last Thursday morning at the Protestant General Hospital, Ottawa, after only one day's illness. Col. Low had suddenly become very ill the previous afternoon with acute blood poisoning, due to ear infection. He was removed to the hospital and operated upon that evening, but he did not recover consciousness after the operation. Col. Low was seriously ill with influenza and pneumonia last fall, which is thought to have been responsible indirectly for the fatal illness. He was 44 years of age and is survived by his widow and one daughter. The body was shipped for interment to Halifax, where the deceased's mother resides.

Although born in Michigan, Col. Low received his early education in Scotland, as his parents were Scotch and they returned home soon after his birth. When he was twelve years old, his family again crossed the ocean, settling at Halifax, where the son commenced his career as a time-keeper in his father's business, later becoming assistant superintendent.

British and Colonial Press Photo.

THE LATE COL. R. S. LOW

When of age he went to the United States for two years, returning to become superintendent of his father's company. In 1899 he entered business on his own account as a general contractor, and in 1912 he joined Bate, McMahon and Co.

At the outbreak of war, he was asked by Sir Sam Hughes to build Valcartier Camp, and he completed the work with exceeding rapidity. Subsequently he built eleven other camps, including Camp Borden, for the Militia Department and the Imperial Munitions Board. On account of the number of soldiers who were working under his direction, it was deemed expedient that he should have military authority, and for that reason on February 1st, 1916, he was gazetted as Lieutenant-Colonel. Two years previously he had been the recipient of an honorary colonelcy.

At the time of his death Col. Low and his firm had several million dollars' worth of work in progress, including a big plant for the British-American Nickel Co., at Deschenes Mills, P.Q.; a million dollar Dominion government office building at Ottawa; housing at Halifax; waterworks, temporary station and car-repairing facilities at the Ocean Terminals, Halifax; new plate mill for the Dominion Iron and Steel Co., at Sydney; military huts at Quebec, London and Kingston; and admission hospital and sewer at London. At the time of the armistice, he was also engaged in the construction of aviation depots at Dartmouth and North Sydney for the United States Navy.

The first six months of last year were devoted by Col. Low entirely to relief work at Halifax, where, immediately after the explosion, he had been appointed manager of reconstruction. Col. Low refused to accept salary or allowance of any kind for himself or his personal staff at Halifax.

Most of his contracts with the government were upon a percentage basis, in which manner he completed several million dollars' worth of work; but he also, during the war, carried out for the government over a million dollars' worth of construction, including improvements to the Halifax fortifications, free of charge, even supplying the engineering and office staff and all necessary plant and equipment.

Col. Low's reputation was obtained almost entirely through his great organizing ability and his power to obtain the maximum amount of work from employees of all grades. At Halifax his day's business started regularly at 7 a.m., never finishing before 9 p.m., and more frequently midnight or later. His own capacity for work was extraordinary, and those who wished to stay very long in his employ were required to show the same zeal and endurance.

He was accustomed to handling big things in a big way, and stopped at no expense when time was the essence of the contract. He used the telegraph like most men use the mail, and no shipment was too large to send by express when machinery was needed. Although a master of detail and fond of elaborate card indexes and cost systems, he was intolerant of all petty things, especially of a monetary nature.

PERSONALS

ANDREW DODS, general manager of the Ontario Sewer Pipe Co., Ltd., has been elected Public Utilities Commissioner for the town of Mimico, Ont.

FRANK BARBER, consulting engineer, Toronto, will address the Engineers' Club of Peterborough on Thursday, February 13th. Mr. Barber's subject will be "The Proposed Hunter Street Bridge, Peterborough."

A. W. HADDON, acting city engineer of Edmonton, has been appointed Professor of Civil and Municipal Engineering at the University of Alberta, succeeding the late W. Muir Edwards. Prof. Haddon will still devote part of his time to the city's engineering department.

W. H. RANDALL, Superintendent of Water Distribution of the city of Toronto, has been named by the nominating committee of the American Water Works Association as trustee for the year 1919-20 for District No. 2, comprising Wisconsin, Michigan, the Dominion of Canada, and all of the New England States.

OBITUARY

GEORGE SHERWOOD HODGINS, editor of "Railway and Locomotive Engineering," of New York City, died last Monday morning of pneumonia at the age of 59. Born in Toronto, Mr. Hodgins was for a number of years on the engineering staff of the Canadian Pacific Railway. Going to New York about twenty years ago, he became engaged in editorial work, and also spent much time in scientific research work. Mr. Hodgins began his newspaper career with "Gas Age," and later was for some time on the "Railway Age." He is survived by a widow and three brothers, Hon. Frank E. Hodgins, of the Supreme Court of Ontario; Frederick B. Hodgins, of New York; and Brig.-Gen. Wm. Hodgins, who has just returned to Canada from France. Interment took place at Toronto.

The Hamilton & Toronto Sewer Pipe Co., Hamilton, Ont., has erected an addition to its plant which will afford an increase of over 50% in output capacity. The company was established in 1860 and is one of the oldest manufacturers of sewer pipe on the continent.