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A weekly paper for engineers and engineering-contractors

PROGRESS ON THE NEW WELLAND SHIP CANAL

A REVIEW OF THE CONSTRUCTION WORK ACCOMPLISHED THIS YEAR ON THE VARIOUS SECTIONS NOW UNDER CONTRACT—SOME ENORMOUS YARDAGES OF EXCAVATION AND CONCRETING.

SINCE the article which appeared in *The Canadian Engineer* for November 5th, 1914, descriptive of the progress made last year on the construction of the New Welland Ship Canal (which is a $50,000,000 undertaking on the part of the Department of Railways and Canals, Canada) construction operations have proceeded on a large scale and there is now much of interest to add. While no new contracts have been let during the year, excellent progress has been made on all sections of the work under way. These sections are Nos. 1, 2, 3 and 5, numbering southward from the Lake Ontario outlet. They comprise practically all the important engineering features of the enterprise, as the remaining sections, *i.e.*, 4, 6, 7, 8 and 9, which have not yet been let by contract, consist chiefly of widening and deepening the present canal. It is the opinion of the Department that the completion of this portion of the work can readily be accomplished before the great locks of the canal are ready for operation. These locks, seven in all, three of which are twin locks in flight, are all in the first three sections of the canal.

Fig. 1 is a recent view of the new harbor of Port Weller, which forms the Lake Ontario outlet. It is interesting to note the progress made during the year, as evidenced by comparison with a similar view which appeared in the issue of this journal already referred to. In all, over 3,250,000 cubic yards of material have been deposited in the two embankments which form the harbor. These embankments extend about 1½ miles into the lake. The trestle from which the material is dumped on the western embankment has now reached the outer extremity of the harbor, while the dyke on the east side is slightly less advanced. The embankments will be 500 feet in width when completed, although at the present time they vary from this width to a width of only a few feet at the end of the trestle. An estimate of the volume of material required for this work is 5,000,000 cubic yards.

As already explained in previous articles, over 50 reinforced concrete cribs of exceedingly large proportions are being constructed to form the substructure of the outer entrance piers and to provide docking in the interior harbor. Six of these cribs have been sunk this season and four are in the harbor awaiting the same operation, while others are being constructed at Port Dalhousie.

Dredging operations have been continued without cessation, three dredges being engaged in the excavation of the entrance channel during the entire season.

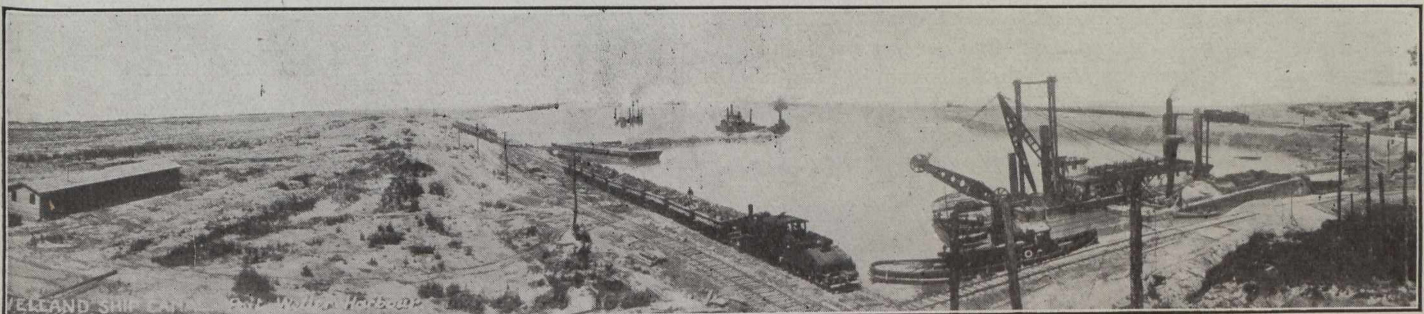

Fig. 1.—Recent View of Port Weller Harbor at the Lake Ontario Terminus of the New Welland Ship Canal.

On the canal proper over 1,700,000 cubic yards of dry excavation have already been completed on Section 1. This work is practically finished, there remaining only small portions to be utilized later for back filling.

Concreting operations on the lock and entrance walls of Lock 1, which is situated a short distance from the lake shore in Section 1, have been under way all season, and at the present time the breast wall at the head of the lock and the west lock wall are both nearly completed. Concreting is under way on the east wall, and the upper entrance walls of the lock are also in course of construction. The reinforced concrete retaining wall below the lock on the west side will shortly be completed. In all, over 65,000 cubic yards of mass concrete and over 14,000 cubic yards of reinforced concrete have been placed in this section.

Fig. 2 is an interesting view taken from the breast wall of Lock 1 and showing the west lock wall, of which a considerable percentage of the total height of 81 feet is now completed. The travelling tower in the background is 112 feet high and operates on four trucks without guys.

It has a capacity of 600 yards of concrete per 10-hour day. The travelling derrick shown at the back of the wall is used for putting in "plums" while concreting.

The contract for Section 1 was let in August, 1913, to the Dominion Dredging Company, Limited, Ottawa, the price being about $3,500,000.

On Section 2, over 3,750,000 cubic yards of excavation have been removed to date, and there are some 2,750,000 cubic yards still to be taken out. The excavation from this section does not all go to the earth dykes of Port Weller harbor. Some of it is transported to the watertight embankments along the canal prism to form the pondages required at the head of Locks 2 and 3. This section, which is 4½ miles in length, includes these two locks, and up to the present some 50,000 cubic yards of concrete have been placed, chiefly in the lock and entrance walls for Lock 2, which has progressed rapidly during the season. The breast wall and upper entrance walls were completed several months ago. Fig. 3 illustrates the west lock wall which is now under construction.

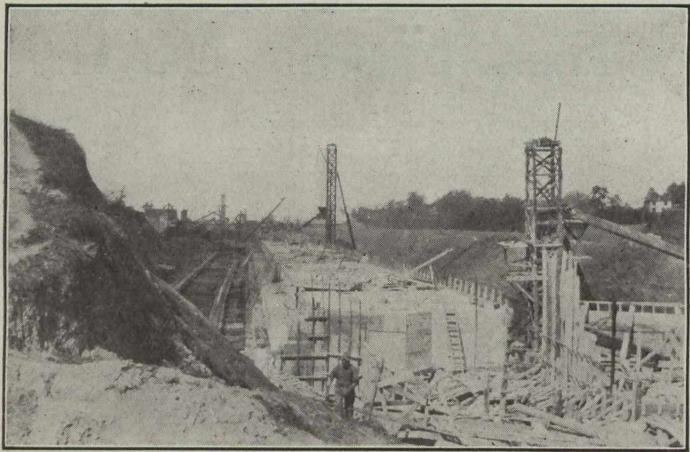

Fig. 2.—West Wall of Lock No. 1 Under Construction.

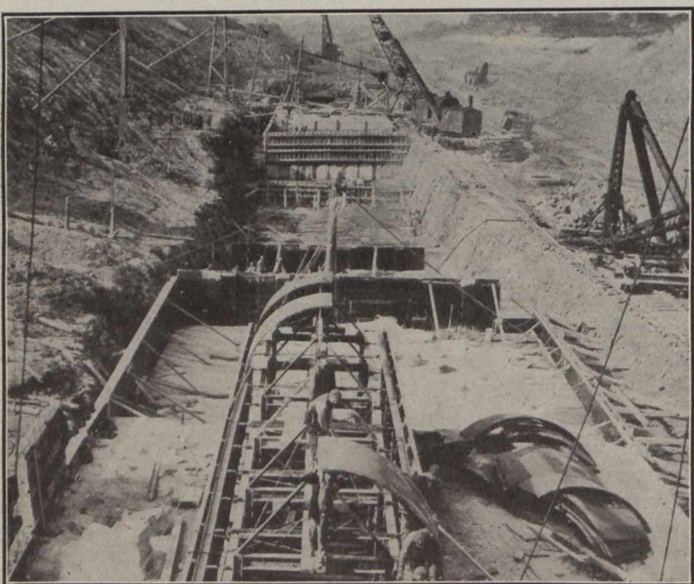

Fig. 3.—West Wall of Lock No. 2, Showing Erection of Steel Forms for Filling Tunnel.

Fig. 4 is an interesting view showing the breast wall of Lock 2 completed to within 10 feet of its height, and showing about 31 feet of this 60-foot wall. In the foreground are to be noted the Blaw steel culvert forms which are being used in the construction of the main filling tunnels in each of the lock walls. These forms are moved on track, travelling the whole length of the lock wall, each of which is about 800 feet long, as the monoliths of which the wall is constructed advance through their various stages of construction. The view also illustrates the wooden forms used on the back of the wall. These are 6-ft. x 12-ft. sections made up of 1¾-inch lagging backed by 3-in. x 8-in. studs at 18-inch centres with walings as shown. While steel forms are being used on much of the work, these wooden forms are preferred by the contractors on Section 2.

In Fig. 5 are illustrated several very interesting features of the walls of Lock 2 and of the general concreting work. The illustration on the left-hand side shows a 10-yard receiving hopper dumping into 1½-yard Stuebner concrete buckets, five of which are carried on a flat car and hauled to and from the crane, the boom of which is shown in the view, by an auxiliary hoist on the crane. In the foreground is shown a metal cut-off used to form a watertight joint between two monoliths or wherever such a joint is required. This cut-off consists of two steel plates joined by a Z-section of copper, a steel plate being embedded in the concrete on each side of the joint. This view shows concreting operations in the foundation of the west wall of Lock No. 2.

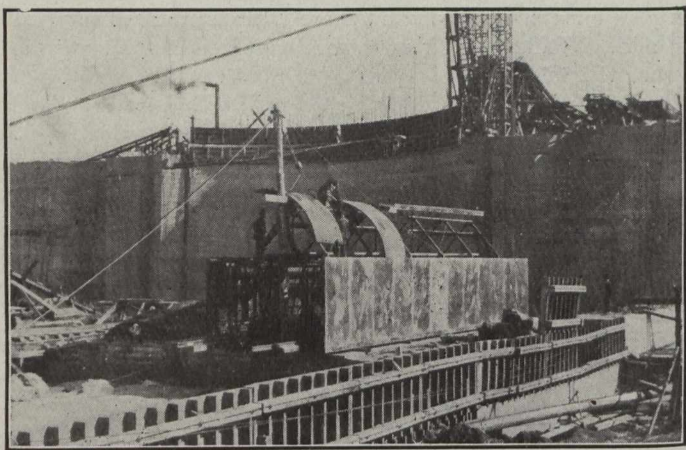

Fig. 4.—Lock 2 Breast Wall Under Construction and Forms Being Erected for Filling Tunnel in the West Lock Wall.

Lock 3, which is situated near the crossing of the new canal with the present canal, is in a less advanced stage of development. Two-thirds of the pit for the breast wall at the head of the lock is within a few feet of rock and one-third is down to rock, having attained a depth of about 65 feet. Lackawanna steel sheet piling, with heavy timber bracing was started last June. Excavation being thus practically completed, pouring of the concrete on a section of the breast wall began last week and will be finished before concreting operations close down owing to cold weather.

Section 2 was let by contract in December, 1913, to Baldry, Yerburgh and Hutchinson, an English firm with a local office in St. Catharines.

Section 3 lies for the most part in the town of Thorold, and is an exceedingly interesting section from an engineering point of view, as it includes the twin locks in flights Nos. 4, 5 and 6 and the single lock No. 7. Lock excavation work in this section is almost entirely solid rock and is proceeding with remarkable rapidity. Over 750,000 cubic yards of rock have been removed during the past year in addition to some 1,700,000 cubic yards of earth. The rock is of exceedingly good quality, and is being crushed by the contractors of Section 3 in a large plant in close proximity to the canal site. This rock is being supplied to the contractors for Sections 1 and 2 in addition to the requirements of concrete work in Section 3. It is a most suitable rock for concrete aggregate and its value will be further enhanced by a large washing plant that the contractors of Section 3 are now installing. In addition to the crushed rock, a large quantity of blasted rock is being supplied to the other sections as "plum" fillers for concrete work.

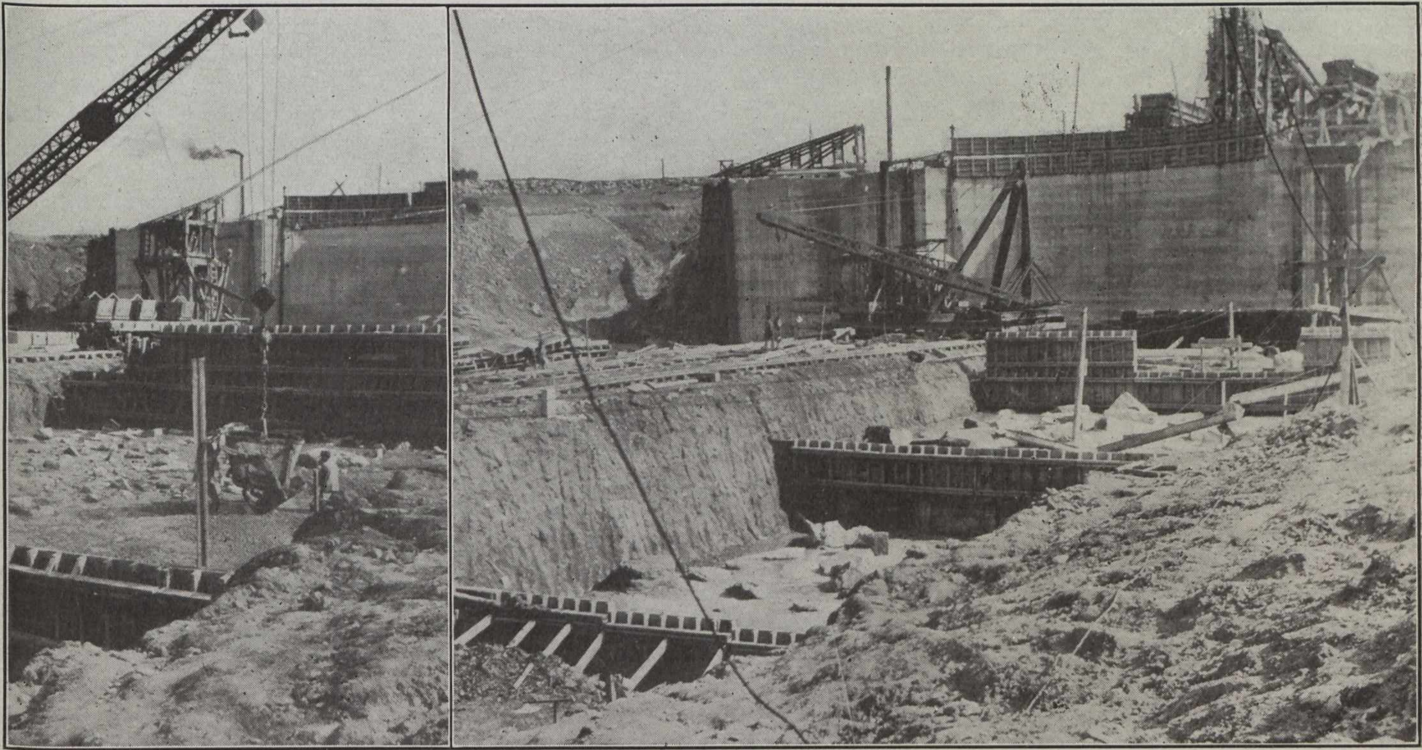

Fig. 5.—Views of Breast Wall of Lock No. 2, and Monoliths of West Lock Wall Under Construction.

Concreting on Section 3 has amounted to approximately 30,000 cubic yards. The upper entrance walls to Lock 6 have been completed, and considerable work has also been done this year on the monoliths at the head of the lock, containing the upper gate recesses.

Several drag-line excavators have been engaged all season in re-handling selected material for use in the large earth dam at the head of Lock 6 to form pondage for the supply of water to the flight locks. A thoroughly water-tight embankment is being constructed and has progressed steadily throughout the year.

During the past year, also, the diversion of the Welland division of the Grand Trunk Railway at Thorold has also been completed. The line originally traversed the site of the flight locks and some 3 miles of diversion were required, involving heavy rock excavation.

Fig. 6 is an interesting view showing a McMyler interstate crane lifting one of the large "plums" into place during concreting operations in one of the lock

Fig. 6.—Handling "Plums" During Concreting

Fig. 7.—Rock Channelling Outfit at Work on Section 3.

walls previously referred to. A few of these "plums" attain a volume of 5 and 6 cubic yards. They come from the rock excavation in section 3. Fig. 7 shows a rock channelling machine in operation on Section 3.

The contract for this section was let in October, 1913, jointly to O'Brien and Doheny, Montreal, and Quinlan and Robertson, Toronto, the price being $9,500,000.

Section 5, which is the only other section at present under contract, involves deepening and widening the present canal on its west side through the deep cut between Allanburg and Port Robinson. This work has made satisfactory progress during the past season, over 2,500,000 cubic yards of dry excavation having been removed to date by a force of five steam shovels. This material is being disposed of on low lands west of the canal. A dredging plant is also in operation, there being several dipper dredges and one 20-inch hydraulic dredge, which is engaged in pumping excavated material into pondages formed in the low-lying lands referred to above. This contract was awarded in December, 1913, to the Canadian Dredging Company, the price being approximately $1,950,000. The excavation work in Section 5 will aggregate approximately 5,000,000 cubic yards.

The entire work is under the direct supervision of J. L. Weller, C.E., chief engineer of the canal for the Department of Railways and Canals, Ottawa. The general features of the design of this important undertaking have appeared in these pages during earlier stages of development. For a clear understanding of the project, the reader is referred to *The Canadian Engineer* for August 21st, 1913.

ROAD DRAINAGE AND FOUNDATIONS.*

By Geo. W. Cooley,

MOST foundation troubles are caused by difficulty of drainage, and, although the value of proper drainage is admitted by all, it is a fact that road engineers and superintendents will in many cases fail to provide for the elaborate drainage necessary to a proper foundation, for the reason that funds are limited, and expensive drainage work reduces the amount of available funds for providing a suitable surfacing. This applies particularly to the great mileage of main rural roads on which there is an insistent demand by road users for surfacing, with impatience at delay or restriction of work on account of the cost of providing proper foundations.

So much has been written on the subject of road foundations that the whole field of investigation has apparently been covered, but in any work of construction there may appear some detail or condition for which there is no precedent, and which must be met by the ingenuity or ability of the engineer or superintendent in charge. As such problems are generally encountered on the improvement of county and local roads, and are apparently of such minor importance that the information is not published or disseminated, a better general knowledge of this work can be obtained by a meeting at least once each year of those in charge of road work throughout each state. It is the lack of attention to details of drainage and foundation work which causes many of the failures of road surfaces, and the relating of experiences at a meeting of those actually in charge of work, with technical advice from proper authorities, would go a long way toward securing more permanent construction.

*From a paper read at the Pan-American Road Congress, San Francisco, Cal., September, 1915.

The drainage of a road must be complete. While the cost of carrying water away from the side ditches of a road often seems prohibitive, the expense is always warranted by the better construction obtained. When impossible to provide complete drainage the elevation of subgrade of the road should be at least 2½ ft. above possible high water.

In providing for cross-drainage only permanent, substantial material, such as concrete, should be used, for the failure of a cross-culvert will not only block the drainage, but will damage the road surface and may cause accidents.

In heavy soil, which appears to be saturated, or in which there is seepage, it is advisable to place drain tile. Tile should be so laid that it will intercept the ground water, and it is frequently necessary to place a line at each side of the road, with leaders or branch lines from the centre of road at 50-ft. intervals. This construction is required on sidehills which develop springy conditions. Rock-filled drains are also used successfully on sidehill work, but are not as efficient as tiling on account of their liability to become partially clogged by sand deposits.

In undeveloped swamp country, the most permanent work is obtained by building the embankment from excavation of a dredge ditch on the upper side of road with an auxiliary road ditch on the lower side. When swamps have soundings of from 2 to 5 ft., the grade line of dredge ditch may be disregarded, excepting as to minimum depth.

In the construction of swamp roads, the top soil is spread first and then sufficient firm material is excavated to provide a substantial foundation. These ditches are dug with practically vertical sides in order to secure the maximum amount of firm material from the bottom, and are of sufficient size to allow for necessary drainage after the breaking down of slopes. The low points in the ditch, where deeper excavation is required to secure material, will fill with sediment after a year or two. It sometimes appears extravagant to make such large ditches on road work, but in new country lateral drainage is always carried to the road ditches, and should be provided for in advance. There is not much difference in cost, however, between hand ditches and a large dredge ditch on account of the lower unit cost of machine work.

After drainage is secured, the important points in road foundations are to eliminate all vegetable or perishable matter and to build up the foundation uniformly. Dragging and planing the subgrade as it is being built will prevent the waviness of surface which develops occasionally after the completion of a road, and it is advisable to place such requirement in specifications.

Surfacing with gravel constitutes the greater portion of rural road work and a great deal of money is wasted in not properly preparing the foundation for this surface. Common practice has allowed the placing of gravel to a depth of from 6 to 8 ins. on clay or heavy soil, frequently on a newly-shaped roadbed. Until compacted, this coat of gravel serves as a sponge, holding the water until the subgrade is softened, thereby allowing the material to be cut through and much gravel lost, with a consequent rutted and uneven condition of surface.

Foundations for gravelling should be firm and hard, and on new work this may be accomplished by forming a crust with a mixture of 2 or 3 ins. of sand or gravel with clay subsoil, rolled to a smooth surface. On sand subsoil it is equally necessary to have a foundation to prevent loss of gravel, and in such cases clay mixture is required.

To prevent loss of surfacing gravel on sand a subgrade, where no clay was available a blanket of vegetable material has been used with complete success. In some cases this has been provided by spreading about 4 ins. of loose straw for the full width of the proposed surfacing, but care much be exercised to prevent the straw from mixing with the gravel. Muskeg or pulverized peat has also been used to advantage under like conditions.

The foundations for higher types of road surfacing, such as concrete, require even more attention than for gravel or macadam roadways. The material must not only be firm, with adequate provision for drainage, but the subgrade must be thoroughly drained out before the pavement is placed. Most of the cracking and failure of concrete roads has been due to moisture in the subgrade at the time frost sets in, and this has frequently occurred where tiling was laid and the road built during the latter part of the season.

The success of any road is dependent upon the complete drainage and uniformity of material in the subgrade or foundation, and it would seem that road authorities could well afford to devote some attention to educating the public along this line, for a knowledge of the necessity of such work is required to secure public support, without which the work cannot proceed intelligently or economically.

SURFACE DRAINAGE IN RELATION TO SEWAGE PURIFICATION.

At the recent convention of the American Society of Municipal Improvements Mr. Geo. H. Norton, of Buffalo, read a paper, entitled "Stream Pollution from Surface Drainage as a Limiting Factor in Sewage Purification," in which the futility is emphasized of trying to obtain pure lake water by purifying the sewage of cities beyond the point where an equal amount of pollution is derived from ordinary surface waters entering the lake. As the author points out, upon the fertile smaller tributary drainage areas will be found the farms and hamlets where the usual sanitary accommodations are those of privies from which the excrement flows away or is periodically spread upon the land. Throughout much of the year these are undoubtedly oxidized by natural processes and do not concern this discussion. Small villages, having commercial water supplies, drain into streams of sufficient size to prevent serious physical nuisance, but partially digested sludge is accumulated in mill-ponds and pools. In the northern climates, however, the winter period of three or four months makes dormant the natural aids, to be followed immediately by the greatest flood discharges, cleaning the whole surface of its accumulations. These discharges often reach the equivalent of 2 ins. or more of water over the entire drainage area. For purposes of illustration, assume that this flushing by spring freshets may bring down one-fourth of the year's accumulated filth of the drainage area, or that one-fourth of 365 days, or 91 days', accumulation is brought down, and that this occurs within a period of 15 days, then there would be one-fifteenth of 91 days' accumulation passing down each day, or six days' accumulation of filth from this drainage area to pass into the great waters each day during the flood periods from sources outside the great cities situated upon them.

To apply this to a specific example, the Niagara River has upon its course an urban population of about 600,000. There enter it from the east two minor tributaries having a population upon their drainage areas of about 100,000. From the above reasoning there would enter from these tributaries during each of 15 days a year, from flood discharge, a pollution equal to that normally entering from the cities along its course.

The fallacy of purification of this stream by exclusion of city sewage alone is apparent if, during 15 days of each year, the condition remains substantially that of normal pollution.

There must be added to this the surface washings of the urban areas, which, at present, seem entirely beyond reasonable limits of purification.

Another consideration pertaining to the general condition of these waters is that of the accumulated flood discharges as affecting the whole body of lake waters.

A rise of 1½ ft. has occurred in a month in Lake Erie from spring flood discharges, representing an addition of one to two per cent. of the whole contents in polluted surface drainage. This does not thoroughly admix, but remains somewhat adjacent to the shores and there represents a greater proportionate pollution.

This condition may be of utmost importance to several of the Lake cities situated at the mouths of comparatively small streams. Due cognizance is taken of the highly-polluted condition of these small streams, and water intakes are located at a distance along the shore such that the dilution, perhaps supplemented by sewage treatment, will apparently ensure a safe supply, and yet the accumulated discharge of some near small stream may, at times, produce a body of water which, under usual conditions of wind and current, may be brought to the intake. This possibility may well indicate the advisability of more thorough water treatment at a less expensive location or a lessened sewage treatment for the city with the same factor of safety secured.

It may be argued that this surface drainage has lost most of its pathogenic bacteria, and is, therefore, comparatively innocuous, but the medical profession is not yet prepared to say that this organic refuse, even without pathogenic bacteria, may not be a marked source of digestive ills.

Under the above assumptions and arguments the conclusion must be reached that any endeavor to improve these waters to a safe potable standard by removal of urban sewage alone will be futile. Nor can it be assumed, within fair reason, that this effect of surface drainage can be eliminated as a practical or immediate probability. Until sanitary science and sentiment have made great strides, surface contamination must continue as a potent factor demanding treatment of potable water supplies, and with such requirement the logical corollary is that only such treatment of municipal sewage is required as may prevent undue burden upon a water plant designed to meet the conditions of surface pollution.

Until sanitary science and education have made greater advance in the rural and suburban territories, the inherent menace of this drainage must be a limiting and controlling factor in any endeavor to render pure the larger bodies of water and to make them potably safe by remedies applied solely by the great municipal bodies along their borders.

WATER POWERS OF BRITISH COLUMBIA.

British Columbia, owing to its wonderful topography, can claim to be one of the greatest water-power countries in the world. The great mountain ranges, rising above the limits of perpetual snow, form inexhaustible storehouses of power and on the Pacific Coast slope the abundant rainfall and magnificent lakes and rivers have created most unusual opportunities for developing the vast natural sources of power that are so much in evidence in the province.

One of the five monographs prepared under the direction of the Water Power Branch, Department of the Interior, for the International Geological Congress at San Francisco, Cal., deals exclusively with these power resources of the Pacific Coast province. It was prepared by Mr. G. R. G. Conway, consulting engineer, Toronto, whose intimate connection, extending over a number of years, with hydro-electric developments in British Columbia, has adequately equipped him for the task, and we are not surprised, therefore, at the masterful way in which the water power data are dealt with in the conspectus. We abstract the following notes as supplementary to the numerous references that have previously appeared in these columns concerning the prodigious power resources of British Columbia:

Only those who have studied water power problems in Canada realize that already there have been installed near the lower mainland in proximity to Vancouver and Victoria hydro-electric plants capable of producing one horse-power for every two persons now resident in the province. These plants have made Vancouver, Victoria and New Westminster among the best electrically served cities in the world, giving them an abundance of cheap electrical energy available for manufacturing and other purposes at a day's notice.

The application of electrical power in the province, in addition to the well-known uses in the cities for electric light, electric street and interurban railways, and for industrial purposes, is largely used for mining, smelting and the manufacture of wood pulp and newspaper, the manufacture of lumber, in the canning industry, and for the smelting and reduction of copper.

The developed water powers of the province are listed in Table I.

In addition to the developments shown in the table, many other schemes of development have been designed which will bring the total of developed powers up to nearly 500,000 h.p.—schemes that will be prosecuted with energy when improvement takes place in financial conditions after the war.

An approximate estimate of the available power, even at a conservative figure, cannot be placed at much less than three million horse-power. It will, therefore, be seen that the actual horse-power utilized at the present time comprises only 8 per cent. of this great total. The whole of these plants have been constructed during the past 17 years, and about half the total of existing powers has been placed in service during the past 5 years.

The Kootenay Light and Power Company's plants at Bonnington Falls, on the Kootenay River and Kettle River, which have at the present time a capacity of 23,000 h.p., can justly claim to have been the first plant of any magnitude in the province. The original hydraulic and

TABLE I.—Capacity of the Principal Water Powers as at Present Developed in the Province of British Columbia

Owner	Situation	Present Capacity Installed Horse Power	Purpose for which energy is utilized
West Kootenay Power & Light Co., Limited	Kootenay River and Kettle River, near Nelson	23,000	Mining, smelting, light and industrial power
British Columbia Electric Railway Co., Limited	Goldstream, near Victoria	3,000	Light, industrial power and street railways
British Columbia Electric Railway Co., Limited	Lake Buntzen, Burrard Inlet	84,500	Light, industrial power and street railways
Western Canada Power Co., Limited	Stave Lake, near Ruskin	26,000	Industrial power (26,000 h.p. now being added)
British Columbia Electric Railway Co., Limited	Jordan River, Vancouver Island	25,000	Light, industrial power and street railways
Ocean Falls Co., Limited	Link River, Ocean Falls	11,200	Wood pulp and lumber manufacture
Canadian Collieries (Dunsmuir), Limited	Puntledge River, near Nanaimo	9,400	Coal mining
Powell River Co., Limited	Powell River	24,000	News print paper manufacture
Granby Consolidated Mining, Smelting & Power Co., Limited	Falls Creek, Granby Bay	7,325	Copper mining and smelting
City of Nelson	Kootenay River, near Nelson	4,000	Mining, industrial power and light
City of Kamloops	Barriere River, near Kamloops	2,800	Light and industrial power
Britannia Mining & Smelting Co., Limited	Britannia Creek, Howe Sound	2,735	Copper mining and reduction
Hedley Gold Mining Company	Similkameen River, near Hedley	2,650	Gold mining
City of Prince Rupert	Woodworth Lake, near Prince Rupert	1,650	Light and industrial power
Swanson Bay Forests, Wood Pulp & Lumber Mills, Limited	Swanson Bay	1,250	Wood pulp and lumber manufacture
City of Revelstoke	Illicilliwaet River, near Revelstoke	600	Light and industrial power
Other small developments described below		890	Mining, municipal and hotel lighting, salmon canning
Total horse power at	present installed	230,000	

generating units were placed in operation early in the year 1898. The Goldstream plant of 3,000 h.p., forming part of the British Columbia Electric Railway Company's system to supply the city of Victoria with light and power, although under construction simultaneously with the Bonnington Falls plant, was placed in operation a few months later during the same year.

The Lake Buntzen plant of the Vancouver Power Company—a subsidiary company of the British Columbia Electric Railway Company—which supplies power to the city of Vancouver and the adjoining municipalities, was first placed in operation in 1905. This plant was originally designed for 12,000 h.p., and was at that time considered of sufficient magnitude to meet the needs of the district for many, many years. Owing to the enormous expansion of Vancouver and the surrounding territory, the Lake Buntzen plant has now grown to 85,000 h.p., while the city of Victoria is now supplied from Jordan River, 40 miles east of the city, and together with the Goldstream plant, has power available up to 28,000 h.p. installed to meet the industrial needs of the community.

It is estimated that within reasonable distance of the cities of Vancouver and Victoria, without going beyond the present-day limits of long distance electrical transmission, 750,000 h.p. can be economically developed—a possibility that will place these cities among the most favored for the expansion of many existing and future industries.

Among other notable powers of the province is that at Powell River where 24,000 h.p. is utilized in the manufacture of pulp and newspaper. At Ocean Falls 11,000 h.p. is utilized for the same purpose.

At the plants of the Granby Consolidated Mining, Smelting and Power Company, Falls Creek, and the Britannia Mining and Smelting Company at Howe Sound, copper smelting is a large and thriving industry.

The Dunsmuir Collieries, which may be said to produce a commodity used in competition with the electrical energy created by water power, utilized nearly 10,000 h.p. at their mines near Nanaimo.

In the construction of many of the larger hydro-electric plants complex engineering problems had often to be solved; *e.g.*, in the construction of the Lake Buntzen plant a tunnel 2½ miles long through granite mountains 4,000 feet high, connecting Lake Coquitlam and Lake Buntzen, was necessary to convey the stored water from the Coquitlam watershed to Lake Buntzen—this tunnel being the longest of its kind in the world. To store water in Lake Coquitlam to feed the thirsty water-wheels an earth dam 100 feet high was necessary. This dam, constructed by means of clay sluiced between huge toes of granite rocks by hydraulic giants, is as massive and secure as the adjoining hills.

On Vancouver Island, for the purpose of obtaining sufficient storage of water for the Jordan River plant supplying the city of Victoria with light and power, a reinforced concrete dam of the Ambursen type, 130 feet high, was necessary. This dam has the distinction of being the highest of its type in Canada, being exceeded in height by only one other reinforced concrete dam, *viz.*, the La Prele dam in Wyoming, and it can further claim to be the highest steel concrete dam in the British Empire.

The Stave Falls plant of the Western Canada Power Company has had to deal with the difficult problem of controlling the heavy floods that flow during the early summer when the snows begin to melt. At this plant, where 26,000 h.p. has already been installed, two large turbines of 13,000 h.p. each are being added to the plant at the present time, and further additions ultimately will bring its capacity up to not less than 80,000 h.p.

Many of the available water powers in British Columbia are capable of being developed under a high head—that is to say, the maximum available fall of water that can be obtained is being used. For example, at the Britannia mines 1,915 feet has been utilized, and at Jordan River 1,145 feet, making these two water powers the highest head plants in Canada.

Among the chief undeveloped powers of the province are the Campbell River Falls on Vancouver Island where, with proper conservation of water in Buttle's and Upper and Lower Campbell Lakes, as much as 200,000 h.p. can be utilized on a peak load. These lakes are in the heart of the great Strathcona Park which the Provincial Government is now opening up with excellent roads, and with careful designing the necessary dams could be made an attractive feature of the park.

Another interesting development which has been designed for supplementing the power supply in Vancouver is that known as Jones Lake, 90 miles east of the city, where 35,000 h.p. can be obtained by harnessing the waters of the lake so that a fall of over 2,000 feet can be utilized.

The Fraser River, too, has unlimited possibilities for the development of water power—in fact the whole province is an exhaustive field for the study and utilization of that power, a field which is now being investigated by the water power branches of the Provincial and Dominion Governments, and also by the Commission of Conservation.

It is sufficient here to state that there is probably no part of the province, north, south, east or west, within range of any possible industry, that cannot be served economically by hydro-electric power.

"With these opportunities," states Mr. Conway, "it is obvious that British Columbia is a fertile field for the establishment of immense industries. Take, for example, what Norway and Sweden have done to use their water powers, particularly in one industry alone, *viz.*, the fixation of atmospheric nitrogen for the production of nitric acid and the manufacture of nitrates. A small plant, established in Norway in the year 1903, utilizing only 25 h.p. for this purpose, has grown so rapidly that now hydro-electric power amounting to 400,000 h.p. is used in its production alone.

"The world's consumption of nitrogen in various forms is about 750,000 tons annually, representing a value of about $250,000,000, and the demand is yearly increasing by about 5 or 6 per cent. Four-fifths of this supply has hitherto come from Chile, but with the new trade routes opened by the Panama Canal there is no reason why British Columbia cannot seriously compete on the most favorable terms in the European market with the natural saltpetre of Chile. These Chilean fields are not unlimited. They are yielding now over 3,000,000 tons annually. In a few years' time the supply must be exhausted, and, in consequence, the fixation of atmospheric nitrogen, begun by the Atmospheric Products Company at Niagara Falls in 1902, is now a great national duty for Canadians to undertake so that our vast water powers may produce fertilizers to assist the agricultural progress of the Dominion.

"Great possibilities, too, exist in the province for the smelting and reduction of ores, and in the refining of

British Columbia copper, which is now done in the United States, when it could be more economically done in proximity to the many water powers. In the production of calcium carbide—a great Canadian industry requiring further development—the possibilities are equally advantageous.

"British Columbia, with its excellent harbors and its many navigable rivers, assisted by the great transcontinental railways, requires many new industries, and the example of Norway in embracing every opportunity to develop industries that require economical water power should be emulated. She has within her borders all that is of material necessity to make a great province, supporting in time to come in prosperity eight or ten millions of people."

HIGHWAY ADMINISTRATION IN CANADA.

MR. THOMAS ADAMS, of the Commission of Conservation, has given voice to one of the most important needs of Canada to-day—the need for improvement in highway administration. We reproduce his observations, drawing particular attention to the emphasis he lays upon the need for a central department in order to secure efficiency.

There are at present highway commissioners in most of the provinces, but they deal with rural highways and are not concerned with the local improvements in cities and towns. It is desirable that every city, town and municipality in each province should have the assistance of a central department on all highly technical engineering questions, including that of road planning and construction. The work of the Road Board in Great Britain and of the Highway Commission of the State of New York are worthy of careful study in this connection, but to be really efficient each provincial highway commission or board should be linked up with a department of local government, dealing with municipal affairs in general and not solely with highways.

The roads in Canada are more important for distribution of produce than in Great Britain where distances are so short and light railways are so plentiful. In Canada we have had to start off without any of the advantages possessed by older countries in the matter of old foundations and the accumulated work of centuries of road construction. We have to develop motor transportation by road as a means of feeding the great trunk railways and securing the economical distribution of food. Manufacturers and contractors seem to have more say in giving advice regarding the material to be used than elsewhere. The respective obligations of the provincial and the local governing bodies in regard to road construction and maintenance have to be considered. Local authorities need to be advised regarding the proper use and value of different kinds of road material, after adequate trial and investigation by an expert department, in order to save hundreds of thousands of dollars spent in unsuitable road material used in local improvements.

When we consider the enormous amount of money spent in roads and road maintenance and the great waste arising from the haphazard methods of carrying out local improvements, it is surprising to find so little effort being made to deal with the matter on more practical and scientific lines. Much is being done in Quebec and Ontario to carry out isolated road schemes but a more concerted and comprehensive effort is needed—and that urgently—in the interests of national prosperity.

The highway commissioners of Ontario in their annual report draw attention to the need of more co-operation between the cities and country districts in the matter of road improvement. Ontario has about 50,000 miles of roads, and the highway commissioners consider that a sum of $30,000,000 should be spent on these roads during the next 15 years. The following apportionment is suggested:—

Province (including revenue from motor fees)	$12,000,000
Counties	12,000,000
Cities	6,000,000
	$30,000,000

To this capital expenditure there will have to be added the great cost of maintenance, which may amount to from $300 to $500 per mile.

The amount appropriated in the State of New York is $65,000,000 for 11,000 miles of highways, and about $50,000,000 has already been spent or obligated. In Great Britain we have seen that one department alone—the Road Board—has raised $32,000,000 for road improvements in four years, almost entirely from motor spirit and carriage licenses. Merely for purposes of road improvement Ontario would require to incur an expenditure of about $3,000,000 annually to bring its current rate of improvement in the settled part of the province up to the British standard. The proposed expenditure of the Ontario Highway Commission at the rate of $2,000,000 annually would therefore appear to represent the minimum, under present conditions. The Ontario Commission is doing excellent work and the same may be stated with regard to Quebec and other provinces. But the whole question of highway administration in Canada needs to be reviewed. Some system should be devised to secure more co-operation between the provinces, the counties and the cities. As already stated, there is a pressing need for a central department in each province to deal with all questions of local government, including highways, town planning, and local improvements. Such a department is necessary to secure efficiency, but it would have to be formed in such a way as not to interfere unduly with the present powers of local authorities.

DIAMOND-DRILLING COSTS IN BRITISH COLUMBIA.

Diamond-drilling costs at the Josie mine of the Le Roi No. 2 Mining Co. were submitted at a recent meeting of the Western Branch of the Canadian Mining Institute, held at Rossland, by E. Levy, manager of the property.

Two machines were kept in operation for two shifts per day, excepting Sundays and holidays. Labor comprised one diamond setter, four runners and four helpers.

The records show as follows:—

Year ending.	Ft.	Labor.	Carbon.	Sundries.	Total.
Sept. 9, 1912......	14,185	$0.73	$0.62	$0.34	$1.69
Sept. 9, 1913......	15,075	.71	.62	.34	1.67
Sept. 9, 1914......	12,249	.72	.60	.32	1.64

Sundries consist of drill-fittings, compressed air, and grease. The Le Roi company does its own diamond-drilling, while at other mines in the camp it was let out by contract. Mr. Levy thought his company was getting better value for its money than that obtained under contract. In exploration at depth in the mines, diamond-drilling is resorted to in Rossland mines; the exploratory work was done at least five times as quickly and at one-tenth of the cost of the usual underground driving.

LOCATION AND GRADING OF SIDE HILL ROADS.*

By E. W. Murray, S.L.S., D.L.S.,
District Engineer and Surveyor, Highways Commission, Regina.

THE system of survey of Dominion lands employed in the prairie provinces which calls for road allowances running astronomically north and south at intervals of one mile and east and west at two-mile intervals, is possibly the best that could have been devised for such an expanse of country. It is only when one approaches the valley of a river, such as the Saskatchewan or Qu'Appelle, or the shore of some of our larger lakes, that the need is felt of a system of base lines following some natural feature. The predominance of level or gently undulating land, however, favors the present system, and complications in direction are reduced to a minimum.

It is for the purpose of negotiating the slopes of valleys of rivers, creeks and dry coulees that the side hill road has come to be very largely used. The side hill road affords in many cases the only practical way of making an ascent with a permissible grade. It is invariably cheaper of construction than any other type of road accomplishing the same change of elevation, and, if properly handled, is as easy to maintain as a road in a heavy cut. The strongest point raised in argument against a road constructed on the side of a hill is the fact that it cannot be used in winter in many cases on account of snow drifting in from the bank above, whereas a road in a straight cut, even if it does drift full, can be travelled without the same amount of danger. The prevalence of sharp turns is held against many such roads, but if properly located, the validity of this objection can be removed.

In the case of a short diversion in a ravine, it frequently happens that one has choice of banks on which to locate his road. In this instance those living nearby should be consulted as to prevailing winds and drifting of snow. As a rule, the east slope of a ravine is more likely to be clear of snow in the winter than the west side, and the south slope has an advantage over the north in this respect.

While the commonest use of the side hill road is to accomplish an easy accent, the method may be used to avoid any change of elevation, as in passing around a large hill on a road allowance. This, of course, is not permissible where the land is valuable and the country thickly settled, but can be used to the very best advantage in a hilly country like the part of Saskatchewan which adjourns the international boundary. Many road surveys are now being made in this portion of the province, and it is surprising how roads reasonably direct between two points and free from all excessive grades can be secured when one has a free hand in locating them. It is to be remembered, too, that the curving road around a hill may be no longer than the straight road over it, for the latter is straight only with reference to the horizontal plane, while it is curved as to the vertical plane, the former is curved as to the horizontal plane, but straight as to the vertical plane. Both lines curve and we call the one passing over the hill straight only because its vertical curvature is less apparent to our eyes. The difference in length between a straight road and one which is slightly curved is very small. The statement has been made that if a road between two places ten miles apart were made to curve so that the eye could nowhere see further than a quarter of a mile of it at once, its length would exceed that of a straight road between the two points by only about four hundred and fifty feet.

In locating a road, geological considerations often determine the best position where it might at first seem immaterial on which side of the valley the road should run; this on account of the inclination of the strata of the underlying rock. The appearance of springs on a hillside is indication of the dip of the strata, and also of the trouble which may be expected to be experienced in the maintenance of a roadway on that side of the valley.

Grades.—The subject of good roads is receiving more attention now than it has at any period of time, and the question of permissible grade is probably one of the most important phases. The grade allowed depends on the size of the load to be hauled and the nature of the road surface. It is reckoned that a horse on the level is as strong as fifteen men, while on a 15 per cent. grade he is less strong than three. A horse can exert for a short time twice the average tractive force which he can exert continuously throughout a day's work, and so long as the resistance on the incline is not more than twice the resistance on the level, the horse will be able to take up the full load he is capable of drawing. Steep grades are thus seen to be objectionable, and more so when one occurs on an otherwise nearly level road, in which case the load carried over the less inclined portion must be reduced to what can be hauled up the steeper portion. The bad effects of steep grades are especially felt in winter when ice covers the road, for the slippery condition of the surface causes danger in descending as well as increased labor in ascending, and the water of rains running down the road gullies it out. It is roughly estimated that the destructive effect of heavy rains is four times as great on a 5 per cent. grade as on the level, and nine times as great on a 10 per cent. grade as on the level. Experiments show that the power expended in moving a load up a 4 per cent. grade is nearly three times that required to move it on the level, while for a 6 per cent. grade the power is four times, and for an 8 per cent. grade five times that required on the level. The Highway Commission of the province have adopted 7 per cent. as the maximum allowable grade on any road which has to be surveyed to replace a road allowance, but on many road allowances where the hill cannot be avoided without a long detour there are still many grades upward of 12 per cent. The closeness of settlement and value of the land often renders any diversion inadvisable, and in that case it should be the ambition of the municipality to have the grade reduced to the standard set as soon as possible. While 7 per cent. is a good maximum for clay roads, it should not be approached where a road is located in sand, in which case 4, or at most 5, per cent. should govern.

Sand is to be avoided where possible in locating a side hill road, but often there is no choice, as at a river crossing where one bank is clay and the opposite one entirely of sand. The prevailing grade will depend also on the length of the hill and the maximum grade should not obtain for a greater distance than five hundred feet at one time. Changes in grade relieve the monotony and make the ascent easier.

Method of Locating.—Having come to the place where it is desired to construct a side hill road of any

*From a paper read before the April meeting of the Regina Engineering Society.

considerable length, it is well first to make a very thorough reconnaisance. If the coulee which is to be made use of has banks free from timber the exploratory work is not as a rule difficult. The presence of timber or brush, however, adds considerably to the work, and if the survey is being made in mosquito season the combination becomes one requiring much patience and perseverance. A little experience in this kind of work should enable one to tell very closely without the use of an instrument by simply walking from the valley out through some tributary ravine the kind of grade which it will accommodate. Consideration of alignment and suitability of the banks for the construction of a road should also be entertained, and further care should be taken to avoid loss of height, by which is meant getting up to a certain point on the bank and then having to descend before the ascent is continued. This is very rarely permissible and invariably the grade approaching such a point can be so adjusted that the troublesome place may be crossed at least on the level. The only case, however, which justifies the introduction of levels into an ascending grade is where such levels will advance the road to its objective point directly.

Having now fixed the grade at, say, 6 per cent., the rodman may cut two pickets in length equal to the height of the eye above the level of the ground and have another man supplied with an armful of stakes from twelve to eighteen inches in length. The clinometer is set and clamped at three and one-half degrees, the angle corresponding to a 6 per cent. grade, and the rodman instructed to proceed down the slope and holding the rod upright move up or down the hill until the clinometer, which is held firmly on top of rear picket, shows the cross line cutting the top of rodman's picket, the point marked by the foot of the rod is a point on the grade and is preserved by driving one of the short stakes. If the hill has no decided breaks, several of these points may be set from the same station. The observer then moves ahead to one of the points so marked and continues the process. The same two pickets are used for sighting throughout and are squared on both ends so as to prevent them entering the ground and introducing inaccuracies in the work. The rodman soon becomes expert and if possessed of a good eye for grades there is little trouble after the first few stakes are set. The use of the clinometer on a timbered hillside in place of the transit expedites the work considerably on account of the smaller amount of cutting required, and with a little care quite as good results may be obtained. It may be found on nearing the flat that the preliminary estimate was in error, and that you are unable to reach the bottom at the point desired. It will be well, then, to reverse the process and run a grade line back up the hill from the required point in the valley. This will probably take you beyond the outlet which was used in coming down and the question of filling across the coulee formerly used as an outlet or going around on its surface will have to be considered. Your action here will be determined largely by the importance of the road, and the nature of the traffic. While the object of this method is to gain length over which the required elevation is to be distributed, this is not always to be acquired at the expense of the alignment of the road. A very accurate idea is now had of what grade can be used and what tributary coulees are to be crossed, as well as the amount of flattening of the grade that can be allowed on curves. The method just described has been in use in the province for many years, and is the best way of locating a grade in such places. Mr. W. T. Thompson, D.L.S., lays claim to its introduction here, and he has laid out many admirable roads in this manner. The term contour grade has been applied to it. As the name might suggest, the grade line is kept on the surface of the slope and the profile of the centre line of a road located strictly in this way would show neither cut nor fill, while the cross-section is such that the material removed from the bank above is to be deposited directly below so that the transverse cut at every point is equal to the fill. Where the ravine being ascended is so short that it has no tributary runways cutting into the surface, a strict adherence to the contour method may be observed, but on a road in a coulee of any length, upwards of ten chains, there are always to be found smaller gullies running into the main depression. The importance of the road is again to be considered in determining whether to cross these gullies with a straight fill or to lay out the road on the surface as before. If earth be wanted for a neighboring embankment, the amount of excavation may be easily increased by moving the centre of the road farther into the hill, with the additional advantage of lessening the liability to slip. When the slope of the ground is very steep, the transverse balance of excavation and fill is to be disregarded and the road made chiefly in excavation to avoid a high embankment.

Where such a fill is required, a long picket is left in the ravine, the top of which gives the height of the finished grade. The grade line having been determined and marked by stakes at intervals suitable to the surface of the hill, and assuming that work on the road is not to be begun immediately, a good practice is to have stakes about two or three inches in diameter, twelve inches long, squared on one end and pointed at the other, driven in flush with the surface of the hill at the foot of each stake which has been already placed in marking the grade line. It will be well to mark these latter in some way as to render them distinct from the stumps of small trees which have been removed in the cutting of the line. This will secure the line from obliteration and render the accurate location of the grade line very easy even if several years elapse before the work is undertaken. On open hillsides the ploughing of a single furrow in line with the stakes which have been driven flush will serve better than leaving short pickets on the surface. These latter are too easily knocked out by animals pasturing on the slopes, or by owners of lands who take exception to a road so located. The furrow is a relatively permanent mark and may be followed years after the location is made. Care should be exercised to have the furrow follow the grade line precisely and the turning of this furrow, if properly executed, gives a side hill road in miniature.

An electro-steel company has announced the results of a series of tests on piston rods made of the steel it manufactures. The steel showed a tensile strength of 123,775 lb. per sq. in. and an elastic limit of 82,600 lb., with an elongation of 24 per cent. in 2 in. and a reduction of area of 53 per cent. In a revolution testing machine 984,933 revolutions were required to break the test piece at a stress of 30,000 lb. per sq. in. This steel, which contains manganese, is produced in an electric furnace.

It was recently announced in the Victoria Parliament that the Kalgoorlie to Port Augustus Railway would be opened for traffic by the end of next year. Up to July 17th between 700 and 800 miles of track had been laid out of the total length of 1,053 miles. Rails weighing 80 lb. per yard were being used, and the scheme allowed for a speed of 30 miles per hour, the curves and general characteristics of the railway permitting this speed.

HORSE *V.* MOTOR TRANSPORTATION OF MATERIALS.

THE question of the advantage, financial and otherwise, of replacing horse-drawn vehicles with motor equipment for the haulage of materials and apparatus is one of frequent recurrence in contracting, manufacturing, and municipal utility organizations. Those who have in mind an investigation into the relative merits of the two methods of transportation will probably find the following tests and their analyses of considerable use and guidance, as the degree of correctness of the deductions from a study of the case is dependent upon the thoroughness of analysis of existing conditions. The specific case demonstrated below relates to the substitution of a 5-ton gasoline motor truck for three 2-horse-drawn vehicles for short hauls, and the method of determining the economic considerations involved is as cited by Henry F. W. Arnold in a recent article appearing in The Engineering Magazine. Before analyzing it, however, it should be remembered that in order to obtain reliable data upon which to base a comparison of the results obtained from the use of automobile truck equipment versus horse-drawn vehicles it is always desirable, and generally feasible, to have the dealer demonstrate the ability of his truck to perform the work in question. Even when a predilection exists in favor of some special make of truck it is well to encourage a demonstration of several makes, in order that a careful comparison may be made of different trucks under actual working conditions.

The case is a manufacturing plant whose product consists of light and heavy machinery, the latter predominating. Although the plant is located on a trunk-line railroad and has its own spur loading tracks, it requires the services of three two-horse trucks to haul machines and material to and from the freight-houses and to make the necessary local deliveries. The management desired to know if the three horse-drawn trucks could be supplanted by one automobile truck and what advantages would accrue financially, or otherwise, if the change was made.

A careful analysis of the existing conditions, considered from all angles, established the fact that a 5-ton gasoline truck would best meet the requirements of the service in question. Accordingly several demonstrations were arranged for.

During the demonstration a careful log was kept of the performance of the automobile trucks and all matters of interest noted. A corresponding log was also kept of the horse-drawn vehicles for the purpose of comparison. Tables I. and II. show summaries of two representative logs kept during the test at the above plant.

Table I.—Summary of Log of 5-Ton Gasoline Truck Demonstration.

Name of truck, ———. Weight, 10,800 pounds. Remarks, ———. Date, April 24, 1914. Weather, rain. Temperature, 50 F. Client, ———.

Total miles	18.00
Total tons material handled	49.49
Total ton-miles	73.66
Average miles per hour	6.27
Total gallons gasoline	6.30
Gallons gasoline per mile	0.35
Per cent. of time spent on road	27.5
Per cent. of time loading and unloading	72.5
Miles per gallon of gasoline	2.82
Gallons lubricating oil per 100 miles	0.50

Table II.—Summary of Log of Two-horse Truck Demonstration.

Name of truck, ———. Weight, 4,740 pounds. Remarks, ———. Date, April 28, 1914. Weather, fair. Temperature, 70 F. Client, ———.

Miles per hour	2.88
Per cent. of time on road	37.6
Per cent. of time loading and unloading	62.4
Total ton-miles	23.25
Total tons material handled	21.23
Total miles	9.95

From a comparison of the summaries of the two logs, we find that the motor truck has 73.66 ton-miles to its credit (a figure that can be taken as a fair average of the daily performance of the truck under normal conditions); while the corresponding figure for one horse-drawn truck, during practically the same amount of time, is 23.25 ton-miles. In the case of the three two-horse-drawn trucks this figure would be 69.75 ton-miles. These results indicate that from the standpoint of material handled one motor truck has a slight advantage over the three horse-drawn trucks. This conclusion was further borne out by the results obtained from other demonstrations.

In order to arrive at an understanding regarding the financial side of the question, a comparison of the initial investments, annual fixed charges, and operating costs is shown in Table III.

Table III.

	Motor Truck	3 Two-Horse Trucks
Initial investment	$4,800.00	$3,154.00
Fixed charges—		
Interest at 6 per cent.	288.00	183.24
Depreciation of motor truck at 10 per cent., exclusive of tires	480.00	
Depreciation of horse equipment: horses, 12½%; wagons, 10%; harness, 20%		358.50
Services of veterinary		60.00
Insurance and taxes	81.80	44.20
Total	$ 849.80	$ 645.94
Operating costs—		
Labor—operator and helper	$1,560.00	
3 drivers and 3 helpers		$3,980.00
Maintenance	312.00	378.00
Tires	360.00	
Gasoline	236.00	
Oil and grease	57.00	6.00
Feed, bedding and shoeing		876.00
Total	$2,525.00	$5,240.00
Total annual cost	$3,374.80	$5,885.94
Annual saving in favor of automobile truck	$2,511.14	

The figures denote a saving of $2,511.14 in the total annual cost of operation in favor of the motor truck; an annual saving that would more than pay the additional initial investment required for its purchase. This saving is largely made possible by the fact that, in the substitution of the motor truck for the horse-drawn equipment, two drivers and helpers will be dispensed with, resulting in an annual saving of $2,420 in labor alone. The data referring to the cost and maintenance of the horse-drawn vehicles are taken directly from the company's books and are therefore accurate. The initial investment for the horse-drawn equipment includes six horses, three wagons, harness, blankets, etc.

In Table IV. is shown the daily cost of operation, the cost of operation per ton of material handled, the cost of operation per mile of material hauled, and the cost of operation per ton-mile performed by the motor truck compared with the horse-drawn equipment. The saving effected in each of these items by substituting the motor truck for the horse-drawn equipment is also shown.

Table IV.

	Cost per Day	Cost per Ton	Cost per Mile	Cost per Ton-Mile
5-ton motor truck..	$10.82	$0.22	$0.60	$0.146
1 two-horse truck ..	6.29	0.295	0.632	0.227
3 two-horse trucks..	18.86			
Saving by using motor truck ...	8.04	0.075	0.032	0.081

Other advantages that would be gained by using the automobile truck in place of the horse-drawn vehicles are: Saving in wear and tear of the shop floors and streets, greater cleanliness of same, less housing facilities required, thus permitting the greater part of the present stables to be torn down or used for other purposes, power-driven auxiliary equipment on truck to assist in loading and unloading heavy material, and ability to make occasional long hauls not possible with horse-drawn equipment.

The investigation of the transportation conditions at the plant under discussion resulted in the following answer to the question submitted by the management: It will be materially to your advantage, both financially and otherwise, to substitute one-five-ton gasoline motor truck for your present horse-drawn equipment consisting of three two-horse-drawn trucks.

Factors in Purchasing Trucks.—When considering the purchase of a motor truck it is sometimes advisable to obtain from the dealers, or manufacturers, a list of the users of the different trucks which have been demonstrated, and send them a list of questions to answer along the following lines:

1. What is the capacity of your truck?

2. Do you find it necessary to operate the truck with a skilled mechanic?

3. What is the mileage obtained per gallon of gasoline and lubricating oil?

4. About how many miles a day do you drive the truck?

5. Over what kind of roads?

6. About what is the average load that you carry?

7. What mileage do you get from one set of tires? or, if not convenient to give this in miles, how long does one set of tires last in months?

8. Do you feel that for hauling a heavy character the ——— truck is satisfactory?

9. Have you any comments or suggestions to make relative to the ——— truck that would be of assistance to a prospective purchaser at the present time?

From the answers to the above questions much valuable information may be obtained at first hand which will prove of considerable assistance in choosing between different makes of trucks.

Attention is directed to an undesirable condition, almost universal, in the haulage of material. Too much time is spent at the terminals in loading and unloading, thereby reducing the earning power of the outfit. Every transportation engineer understands the importance of keeping the equipment moving the largest possible per cent of time. By referring again to Table IV., it will be noted from the summaries of the log that, while the speed and consequently the mileage of the motor truck is nearly twice that of the horse-drawn vehicles, the per cent. of time actually spent on the road is less. It is interesting to state, also, that, although the material handled was of a very heavy character, certain recommendations—two removable nesting bodies handled by electric travelling cranes, and the installation of a light, self-powered jib crane on the truck—were made, which would result in the reduction of idle time by at least fifty per cent., thereby considerably increasing the earning power of the truck.

UNITED STATES STEEL PRODUCTION.

The total production of steel ingots and castings in the United States in 1914 amounted to 23,513,030 tons, according to the American Iron and Steel Institute. This output compares with 31,300,874 tons in 1913 and 31,251,303 in 1912. The ingots production alone last year was 22,819,784 tons, compared with 30,280,130 in 1913 and 30,284,682 in 1912. The output of castings in 1915 was 693,246 tons, as against 1,020,744 and 966,621 in the two previous years, respectively. Of the 1914 total output of ingots and castings, 17,174,684 tons were made by the open-hearth process, 6,220,646 by Bessemer, 89,869 crucible, 24,009 electric and 3,522 miscellaneous.

All kinds of finished rolled iron and steel produced in the United States in 1914 amounted to 18,370,196 tons, compared with 24,791,243 tons in 1913 and 24,656,841 in 1912. The 1914 output was made up of the following classes: Iron and steel rails, 1,945,095 tons; plates and shapes, 4,719,246; wire rods, 2,431,714; structural shapes, 2,031,124; nail plate, 38,573; and bars, skelp and other forms, 7,204,444.

Production of iron and steel plates and sheets in 1914 aggregated 4,719,246 tons, compared with 5,571,073 in 1913. Merchant bars produced last year amounted to 2,523,631 tons, against 3,957,6c9 in 1913. The 1914 concrete bars output was 288,471 tons, compared with 319,670 in the previous year. The production of tinplates last year amounted to 1,939,785,000 pounds and terne plates 146,105,000 pounds, compared with respective figures of 1,708,186,000 and 136,944,000 for 1913.

Legislation to require the railways of the United States to build nothing but steel or steel underframe cars and to withdraw the wooden cars within a given period has been advocated for several years, but Congress has never taken any definite action. There would now appear to be no need for such action, as the railways themselves have practically discontinued the building of wooden passenger cars, and such cars as are now in service will be withdrawn as they become worn out or obsolete. At the rate at which the change is now going on the larger proportion of the railways will have all the steel cars required for high-speed and heavy traffic within a compartively short time. In fact, many of them are now in this condition.

Underground development and surface betterments to cost not less than $1,000,000 are being considered in plans for operating its extensive holdings in Western Canada by the British Columbia Copper Co., according to Oscar Lachmund, general manager. H. D. Quimby will be associated with the company as field engineer. "Eventually we plan to erect a 2,000-ton daily capacity concentrator at our Copper Mountain properties, which will cost about $500,000," said Mr. Lachmund. "This will be operated by a power plant, either at Princeton or Coalmont, that will require approximately $300,000 to construct and equip, and if the Kettle Valley Railway Co. does not extend its line to Copper Mountain we will construct an aerial tram from the camp to Princeton, about nine miles."

MONTREAL WATERWORKS SITUATION

AN OUTLINE OF THE ENTIRE SCHEME AS ORIGINALLY CONSTRUCTED AND OF THE WATERWORKS EXTENSIONS AND POWER DEVELOPMENT NOW UNDER DISCUSSION.

AN interview accorded to *The Canadian Engineer* last week by T. W. Lesage, engineer-superintendent of Montreal waterworks, reveals the fact that the city engineering department feels certain that its plans for the aqueduct enlargement will bear the light of any investigation, but that it deeply resents the engineering criticisms that have been levelled at the scheme, and opposes the investigation which has been requested by the Council of the Canadian Society of Civil Engineers and by the Montreal Board of Trade.

On the other hand, interviews given by many prominent hydraulic and electrical engineers, resident in and near Montreal, show that there are doubts regarding the advisability of going ahead with the aqueduct enlargement, and that investigation by independent engineers should be made. It is doubted whether the work can be completed within the cost named by the city engineering department; whether 10,000 h.p. will be obtained under the present plans; whether frazil may not cause a complete shut-down of the plant during the winter; and whether the whole scheme is not too costly even if it be finished within the amount estimated, and even if 10,000 h.p. be developed without frazil troubles.

The Aqueduct Scheme.—The city of Montreal formerly obtained its water supply from an aqueduct, or open canal, built about 1854 to supply and pump five million gallons daily. The aqueduct intake was located above the Lachine Rapids, because it was thought that purer water could be obtained there than from any other source, and on account of the possibility of making use of the difference in head for pumping purposes. The aqueduct, which formed the head-race, is over five miles in length. Its position is shown in Fig. 1. In 1903, when the city was pumping nearly 25 million gallons daily (about 10 million gallons by water-wheels and about 15 millions by steam power), agitation was begun for the increase of the supply.

In 1905, City Engineer George Janin laid before the water committee of the Montreal City Council, a scheme to widen the aqueduct and to develop from two to five thousand horse-power, sufficient to pump 50 million gallons a day, the estimated cost of development being $2,132,000. About $1,460,000 was expended on this scheme, an $800,000 contract being awarded to Quinlan & Robertson for excavation work in enlarging the aqueduct, and $660,000 being spent on the construction of a 9-ft. reinforced concrete conduit, paralleling the aqueduct. This conduit, a section of which is shown in Fig. 2, was to supply the pumps during enlargement of the aqueduct, which, it was intended, should remain empty for three years, during construction work. The conduit was built in 1907-1909, and it was planned to have the enlargement completed by the end of 1912. While the City Council was making an inspection trip over the work, Mr. Janin remarked:

"It would, perhaps, be more economical to not only enlarge the aqueduct in the proportions stated in the contract now being carried out, but to make it large enough to obtain power for double the amount of pumping provided for, as well as sufficient power for other municipal requirements."

In November, 1910, Mr. Janin presented a report to the water committee recommending the further enlarge-

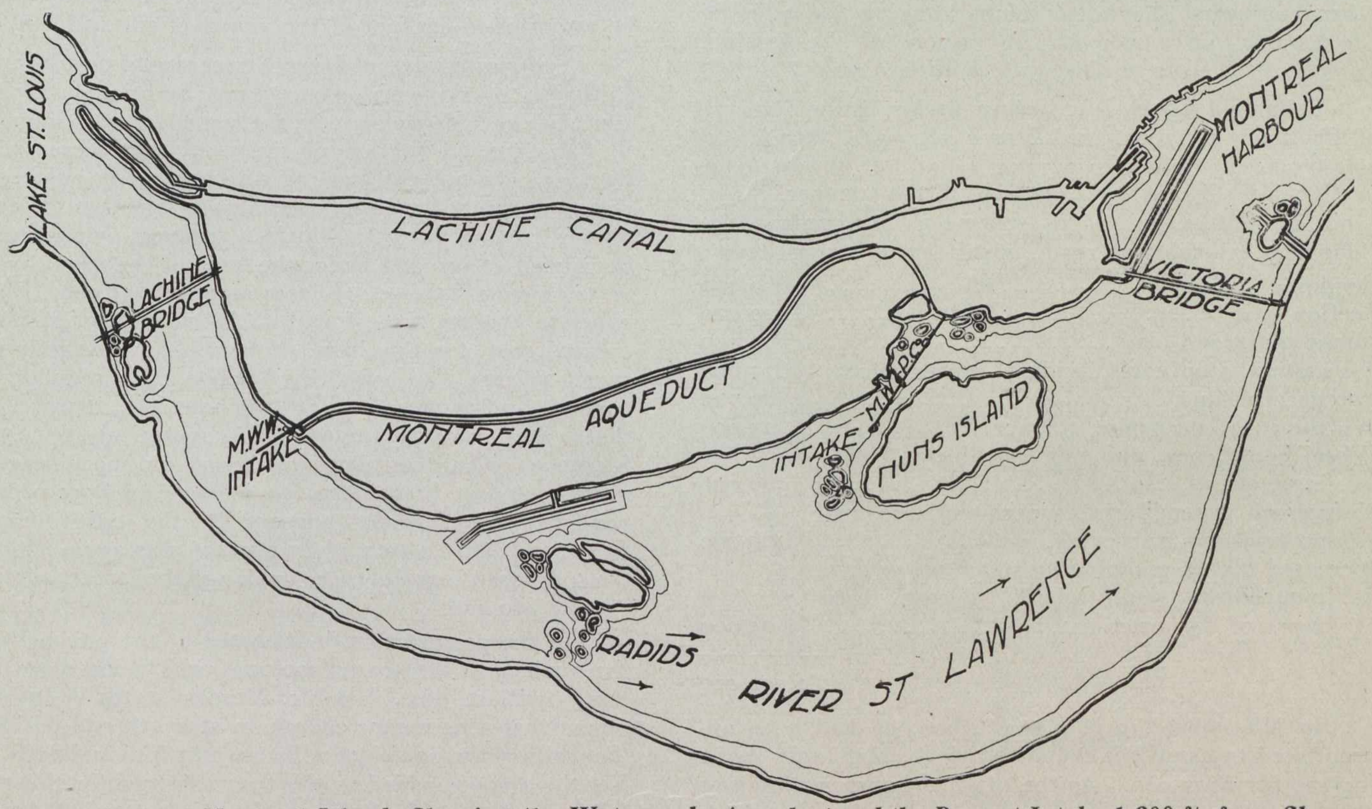

Fig. 1.—Part of Montreal Island, Showing the Waterworks Aqueduct and the Present Intake 1,200 ft. from Shore.

ment of the aqueduct in accordance with his previous remarks. Over his signature he stated: "I recommend the adoption of project D at an approximate cost of $1,900,000, to produce a minimum of 10,000 h.p. at all seasons, that is 7,000 more horse-power than provided for at the beginning of the project, of which 3,000 h.p. would be applied to pump an extra 50 million gallons of water, leaving 4,000 h.p. which could be utilized for other municipal requirements (lighting buildings, streets, parks, etc.) and can be considered worth $25 per h.p. per annum, whilst the cost of production would not cost over $12.62 per horse-power as established in my estimate hereto annexed."

It was decided to adopt Mr. Janin's suggestion, and new tenders were called for the further excavation work required. The Cook Construction Company were the low bidders, and started work in July, 1913. The amount of their contract was $2,232,000, or $332,000 more for the excavation work than Mr. Janin had estimated. But this was only the beginning of the expansion of the cost, which is now estimated by the city at $8,000,000 and by other engineers at various sums ranging as high as $10,000,000 to $12,000,000. A resumé of the gradual growth of the costs on this work is interesting.

Estimated Costs.—According to Mr. Janin's report of February 27, 1905, and March 18, 1907, $2,132,000 was required in order to develop 2,000 h.p. at low water in the winter season, or 5,000 h.p. in the summer. (Mr. Janin later on refers to this scheme as a 3,000-h.p. development.) This was made up of the following items:

Conduit	$ 660,000
Suction well	20,000
Intake pipes and pier	75,000
Excavation, stop gates, bridges, fences, etc.	817,000
Purchase of land	20,000
Widening and deepening tailrace	45,000
Wheel house, new pumping machinery, buildings, etc.	300,000
Unforeseen expenditures, superintendence, expropriations, surveying, etc.	100,000
Increased cost of pumping by steam water now pumped by water wheels, during three years of construction	95,000
	$2,132,000

In November, 1910, after $2,000,000 had been appropriated to carry out the above work, Mr. Janin asked for another $675,000. As the original appropriation was $132,000 short of his requirements, and as $60,000 of the appropriation was spent for a new steam pumping engine, Mr. Janin was really increasing his original estimate by only $483,000 in asking for this vote of $675,000. Mr. Janin said this additional sum was required on account of purchase of land at $4,000 an acre instead of $1,000 an acre, as previously estimated; Hering & Fuller's consultation charges, $12,000; double line of pipe from intake out into the St. Lawrence River, etc.

In this same report Mr. Janin again urges the development of another 7,000 h.p., and says: "Cost of producing 7,000 h.p. more than provided for in present project, as follows:

"Enlargement of aqueduct	$1,900,000
"Enlargement of tailrace	50,000
"Machinery, turbines, pumps, etc.	250,000
"Buildings, foundations, weirs, etc.	100,000
	$2,300,000

Thus, the estimate at that date for the 10,000-h.p. development was $2,132,000 plus $483,000 plus $2,300,000, or a total cost of $4,915,000.

By 1913, however, this figure had grown considerably. The purchase of property by expropriation was estimated at $175,000. The estimated cost of enlargement of aqueduct and tailrace was increased by no less than $850,000. An item of $50,000 was added for direction and superintendence of the work. Bridges, fences, etc., required an additional $175,000. Regulating gates, deepening approach channel and further jetty construction, etc., added $450,000. The item for power house and equipment, however, seemed to be reduced by $100,000. This all meant an addition of $1,600,000 to the previously admitted cost of $4,915,000, or a total cost of $6,515,000.

City Engineer Janin went to the war, as an officer in the engineering corps, and his work is being carried on by Mr. Paul E. Mercier, deputy chief engineer of public works. Mr. Mercier reported to the Board of Commissioners on June 16, 1915, that still further outlays would be required on account of the aqueduct enlargement.

A retaining wall at Bond Street would cost $25,000. Purchase of property required an additional $25,000. The cost of enlargement of the aqueduct was increased by $212,562. Direction of the work was increased by $37,864. To prevent flooding of the property adjacent to the aqueduct, it would be necessary to construct drainage ditches costing $25,000. Surface drainage would have to be carried across and under the head of the canal by culverts, costing $15,000. Fences required $35,000. Eleven concrete bridges were found to be necessary, at an increased cost, for this item, of $370,000. The jetty construction cost was raised by $25,000. To regulate and control the flow of water into the aqueduct, it was found that entrance gates must be provided at a cost of $100,000. The item for power house and machinery was re-estimated at $1,500,000, an increase of $950,000. A new item—boulevards—appears in the cost sheet at $125,000. Thus a total of $1,945,426 was again added to the proposed expenditure, making the total admitted cost $8,460,426.

At the present time it is stated at the city hall that the boulevards will cost $200,000, or $75,000 more than estimated last June, and Mr. Mercier states in his June report that a necessary change in strength and design of the walls of the aqueduct will cost an additional $565,000. Yet the amount added to the 1913 estimate for this work falls short of this $565,000 by the sum of $352,,438. Adding these items to the total cost, brings the sum to $8,887,864. It is also stated that further land is required on account of moving the centre line of the aqueduct further away from the conduit, but it is unknown just how much this land will cost.

Claims have been fyled with the city by the Cook Construction Company for rental of machinery which has been idle for upwards of two years on account of the city not obtaining certain rights of way. These claims total about $250,000.

In December, 1913, a section of the conduit broke owing to the work being done in enlarging the aqueduct. The cost of repairing this break and safeguarding this conduit for about 2,000 feet, and the cost of an extra intake from the Lachine Canal, which had to be constructed for auxiliary supply, were paid for by the city and are understood to have amounted to about $400,000. Adding these items, both of which are directly chargeable to the work of enlarging the aqueduct, brings the cost of the entire scheme to $9,537,864.

On account of danger of interruption to the hydro-electric plant, it may be necessary to have an auxiliary steam plant, which might cost a half million dollars, even after utilizing such machinery as possible from the existing pumping station.

Also, in the event of the city using aqueduct power to light the streets, squares and public buildings, there will be required an expenditure of probably $800,000 for lamps, poles, wires, sub-stations, etc., all of which are now owned by the Montreal Light, Heat & Power Co.

Adding these two items brings the probable total cost of the scheme to $10,837,864. To this should be added the difference in cost of pumping by steam for the past four years the 3,616 million gallons yearly that were previously pumped by the water-wheels. This was estimated by Mr. Janin at about $32,000 a year, making a total of $128,000 for the four years. As the enlargement cannot be completed for another three years, this adds another $96,000 to this item, thus totalling $224,000. Adding this item to the total cost, gives a sum of $11,061,864. To this must also be charged the discount on the bonds already sold for aqueduct enlargement, and also the interest during construction, all of which will probably bring the total to approximately $11,500,000. It must be remembered that this cost is largely calculated from the city engineer's own figures and assumes that they are not now underestimated. It would, therefore, appear that the engineers who claim that the work will cost from ten to twelve million dollars, may not be far wrong.

Commissioner Cote, in his letter to Mr. Jamieson, calls attention to the fact that a considerable portion of the aqueduct expenditure is chargeable to water supply and not to power development. One hundred and sixty million gallons of fair water could likely have been secured through two conduits similar to the present 9-ft. conduit which cost $660,000. This would have involved an expense of not over $1,300,000 for the two conduits. Adding, say, $700,000 for intakes, etc., means that for $2,000,000 the city might possibly have obtained an abundant supply of water. Moreover, with the $2,228,000 that is being spent on a 100-million-gallon filtration plant, at least one of the two conduits might have been unnecessary, as the filtration plant could possibly handle the kind of water that would have been obtained from the old aqueduct. However, allowing $2,000,000 chargeable to water supply, and allowing $1,000,000 of the power plant as chargeable to water pumping (Mr. Mercier's own estimate), not over $3,000,000 of the scheme appears to be directly chargeable to water supply, leaving about $8,500,000 chargeable to power development, or a capital cost of $850 per horse-power if 10,000 h.p. be developed.

Hydraulic Features.—The effective head is said to be doubtful. Commissioner Cote, in an open letter to Mr. J. A. Jamieson, consulting engineer, Montreal, claims 16 ft. head in the winter at low water, with from 10 to 12 ft. more during summer. It is estimated by hydraulic engineers that there may be considerably less effective head on account of the backing-up of the tail water due to ice jams in the river below the city, and on account of the friction loss in the long headrace, especially when frozen over. Engineers point out the fact that although much money has been expended on the headrace, the head gates and power plant have not yet been designed, which is unusual in construction of a work where all elements are so interdependent as in a hydro-electric development.

Mr. Lesage tells *The Canadian Engineer* that arrangements were made with two Montreal engineers to design the head gates and power house. These men, however, were not asked to make any study or report on the whole scheme, and were, in fact, to be retained as designing engineers for that part of the scheme only. One of these two engineers has frequently stated that any power development costing not over $100 per horse-power is sound financially, but that developments costing over that sum should receive careful study. It would be interesting to know his views on this entire scheme, where the cost per horse-power is admitted to be many times $100.

Frazil.—Will frazil reduce or stop the power production during mid-winter months? There are about three miles of rapid, open water above the intake, an ideal condition for the formation of frazil. The Lachine hydraulic plant, with its intake located about 1½ miles below the aqueduct intake, is practically shut down every winter on account of frazil. The large amount of water that would likely be drawn into the aqueduct to develop 10,000 h.p.

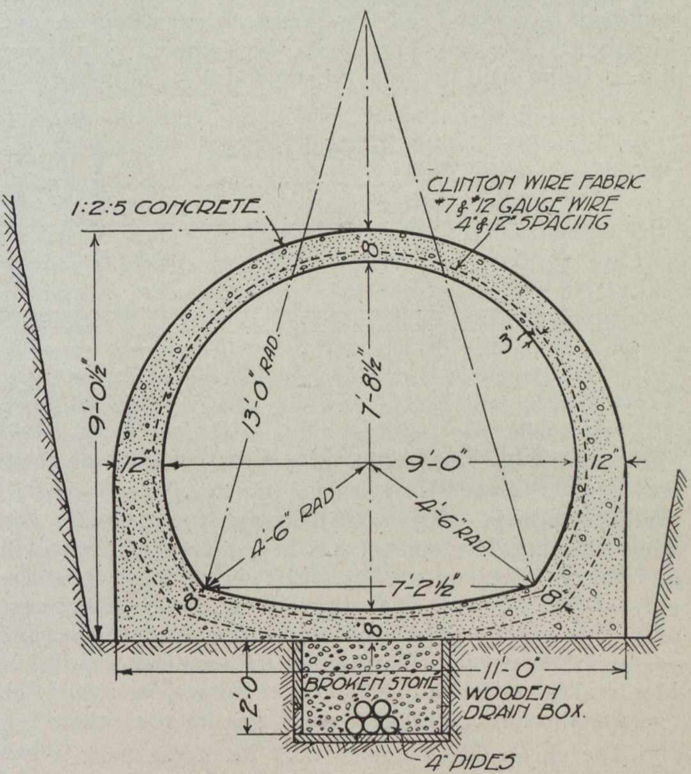

Fig. 2.—Cross-section of Intake Conduit, Montreal Waterworks.

may draw water from the open river instead of from ice-protected shore line as the aqueduct has done in the past. Mr. Lesage, however, claims that their covered forebay will protect them from frazil troubles.

Cost of Power Obtained.—Mr. Janin's report of November 3, 1910, estimates the cost of operation at $24,750, for 7,000 h.p. He figures repairs on machinery and depreciation at 5½ per cent., but applies this to only $250,000 for machinery. Applying this amount also to the additional $300,000 of machinery required to develop the full 10,000 h.p., would add an annual expense of $16,500, making total operating expenses $41,250.

It has already been shown that the possible cost of the development will be $8,500,000. At 5 per cent. this would mean a yearly charge of $425,000. Adding the $41,250 operating expense, gives a total of $466,250 per annum. The cost of operating 3,300 arc lamps at $20 per annum is $66,000, thus making the yearly expense $532,250. This is taking Mr. Janin's own figures for operation. Mr. Cote said it cost $495,000 to do this pumping and lighting for the year 1914, but as improvements have been made in the steam pumping plant, figures given out by the city show that probably $60,000 less coal will be used in 1915 than in 1914, making present pumping and lighting cost about $435,000, or about an even $100,000 less than doing the same work with aqueduct power.

Leaving the distributing system and the operating costs out of the question, however, the mere fact that the cost of the development may be $850 per horse-power or more, is sufficient to call for an investigation into the whole scheme. The interest charges alone on such an amount would be $42.50 per horse-power per annum, even if 10,000 h.p. be developed without frazil troubles. Now, could the city get 10,000 h.p. for less than the mere interest charges on the aqueduct scheme?

Power Rates in Montreal.—Nowhere on the American continent is power being developed cheaper than around Montreal. The new Laurentide development of 125,000 h.p. is being paid for by a $6,500,000 bond issue, or $52 per horse-power. Cedars cost $90 per horse-power, and when ultimate development has been completed, this will be reduced, it is said, to $75. Shawinigan cost considerably less than $100, and the latest development there cost only $50 per horse-power. It is said that the average cost of all the developments within a transmission radius of Montreal is not much over $100 per horse-power, and the average throughout Canada, $125 per horse-power.

The cheap developments near Montreal make a low rate for power possible. The Aluminum Company of America is said on good authority to have contracted for power at $12 per horse-power per annum from Cedars, and to have been given other inducements at that. The Montreal Water & Power Company is said to have a $20 rate for 20-hour power in the winter months and $24 for 24-hour power in the summer. The city itself at present has a $20 rate for 20-hour power and a $30 rate for 24-hour power. And no steam standby would likely be necessary for the city if they contracted for the 10,000 h.p. from one of the power companies, on account of the way the various Montreal plants are tied together for emergencies, and on account of the splendid steam standby that the Montreal Light, Heat & Power Company are now constructing.

The power contract manager of the latter company states that they are prepared to sell the city 10,000 h.p. (6,000 h.p. for pumping and 4,000 for lighting) at $25 for 24-hour power or $20 for 20-hour power. He claims that the pumping could all be done with 20-hour power, and that the right would be given the city to use 24-hour power at any time without notice and without any extra charge, in case of a big fire or other emergency. Mr. Lesage, however, says that on account of small reservoir capacity, it is very doubtful if 20-hour power would suffice. The Montreal Public Service Corporation stated that they had not been approached by the city in connection with this matter, but that they would be quite willing to offer the city reasonable rates when the request is made.

It is also suggested that the city could possibly build a new, modern steam power plant to produce 10,000 h.p. at a lower cost per annum than by the aqueduct scheme.

The city also has the club that it could use on the private power companies of going to Quebec for a hydro-electric bill similar to Ontario's, in case a fair contract with the companies could not be made.

It is not suggested that any one of the alternative schemes will be found advisable in view of the large sums already spent on the aqueduct, but the question is so debatable that an investigation of the whole problem is vital.

Reports of Consulting Engineers.—Commissioner Cote and Engineer Janin have claimed that many consulting engineers have reported on this aqueduct scheme and have approved it. They name Engineers Vanier, Kennedy, Marceau, Hering, Fuller, Butler and others. All of these engineers unqualifiedly deny having made any report on the whole scheme, although they did all separately report on various parts of it, but none of them, with one exception, reported on any part of the present scheme, and he only on the aqueduct walls.

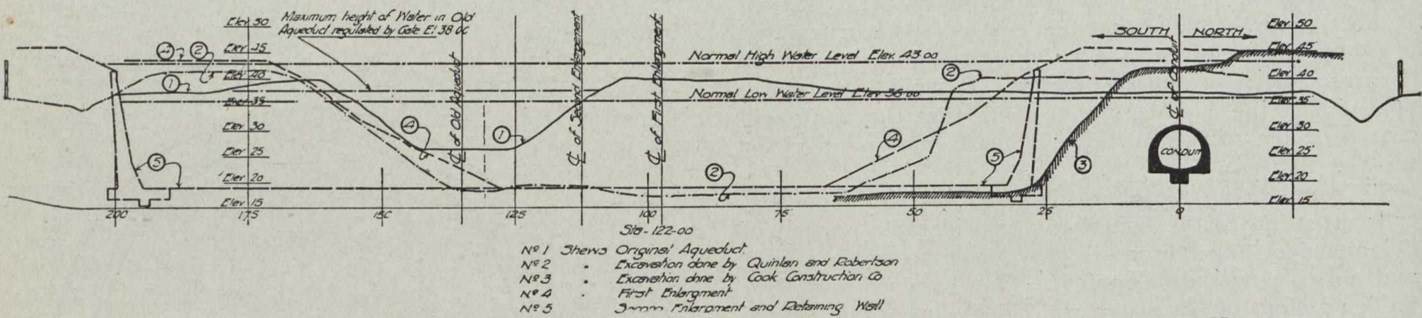

Fig. 3.—Comparative Cross-sections of Original Aqueduct and Enlargements No. 1 and No. 2.

Conclusion.—*The Canadian Engineer* does not wish to be misunderstood as condemning the aqueduct enlargement or as even adversely criticizing same, because it is not the function of an engineering paper to do so, and anyway there are not sufficient facts now available to form fair judgment on the scheme. *The Canadian Engineer* has merely attempted to present the data that are available, from which is is quite apparent that a study of the whole situation is imperative. *The Canadian Engineer* therefore fully endorses the request that has been made by the Canadian Society of Civil Engineers, and approved of by Montreal's Board of Trade, that the project be reported on by a board of independent engineers.

A triumph for the wireless telephone was achieved on October 21st, 1915, when Mr. B. B. Webb, one of the engineers of the American Telephone and Telegraph Company, stationed at Washington, D.C., spoke into a transmitter that sent his message to the Eiffel Tower, Paris, 3,800 miles distant, and to Honolulu, 4,900 miles distant, the two receiving stations being 8,700 miles apart.

GOVERNMENT ELEVATOR AT CALGARY.

By C. D. Howe,
Chief Engineer, Board of Grain Commissioners of Canada.

THE Canadian Government elevator at Calgary is a reinforced concrete terminal elevator of 2,500,000 bushels capacity. This interior elevator, together with similar elevators of 3,500,000 bushels capacity each at Moose Jaw, Sask., and Saskatoon, Sask., were constructed by the Board of Grain Commissioners for Canada to operate in connection with the Board's lake terminal elevator at Port Arthur, Ont., and with the Board's ocean terminals at Vancouver, B.C., and at Port Nelson, Hudson Bay, the two last-mentioned elevators being now under construction. The purpose of the Calgary elevator is to provide storage and cleaning and drying facilities for grain grown in Alberta, and to act as a reservoir for shipments eastward via the Great Lakes, but more especially for shipments westward to Vancouver.

The Calgary elevator is of fireproof construction throughout and consists of a working house of 500,000 bushels capacity, and a storage annex of 2,000,000 bushels capacity. The receiving capacity is 18 cars of grain per hour, and the loading out capacity 36 cars per hour. The drying plant has ample capacity for drying 24 cars of grain per day, and the sacking plant, a capacity of 20 cars per day.

The elevator is electrically operated, power being supplied by the city of Calgary at 12,000 volts, and stepped down in the elevator substation to 550 volts for power purposes, and 110 volts for lighting. A separate motor drives each machine. A Cyclone dust collector system and a compressed air system are included in the equipment.

The elevator is especially well equipped for cleaning grain, its cleaning equipment consisting of ten receiving separators, two flax separators, two wheat and oat separators, and a screenings separator. These machines are all of large capacity, and the equipment provides for all ordinary grain separations, as well as for cleaning seed grain. A screenings grinder of large capacity is installed to chop elevator screenings for feed purposes. All grain is weighed on hopper scales located in the working house cupola, six scales of 2,000 bushels capacity each being installed. Two automatic sacking scales are included in the elevator equipment. A boiler house containing two 100-h.p. marine type boilers furnishes steam for drying grain.

The elevator is connected by direct spur trackage to the Canadian Pacific and the Canadian Northern railroads, and by a transfer connection to the Grand Trunk Pacific Railroad. Ample trackage for loading and unloading and sorting cars is provided at the elevator site. The total cost of the Calgary elevator was approximately $1,000,000. Janse Bros., Boomer, Hughes and Crain were the general contractors, and the engineering staff of the grain comissioners were the engineers.

WINTER ROAD CONVENTION.

The American Road Builders' Association has decided to hold its next convention and exhibition during the month of either January or February next. No decision has yet been reached as to the place of meeting, but it is expected that either Cleveland, Ohio, or Pittsburgh, Pa., will be chosen.

"RELATIVE STABILITIES" IN POLLUTED WATERS CARRYING COLLOIDS.*

By Arthur Lederer,
Sanitary District of Chicago.

AS a rule, all river waters contain more or less colloidal matter in the form of very finely divided silt. Polluted waters also carry colloids of sewage origin mainly derived from the fecal matter. Only recently has the importance of colloids been recognized in sewage disposal and water purification. We know that the colloidal matter in sewage affects the putrescibility of the liquid more than the heavier, coarse, suspended matter. The removal of the colloids by simple filtration—not biologic filtration—results in an improvement which is, however, much less than the one effected by biologic treatment, but far more than by settling. The study of colloids has given the science of chemistry a new aspect. Colloidal chemistry has explained some phenomena in nature as well as technology, heretofore not clearly understood. We differentiate between crystalloidal and colloidal state of matter. A very large number of inorganic substances, heretofore known only in the crystalloidal state, have been prepared in the colloidal. Some substances, such as proteins, starch, gum and glue, are known in the colloidal form only. Suspensions of colloidal clay remain suspended in the water for days and weeks. The addition of electrolytes, such as common salt, sodium sulphate, calcium sulphate, or sodium nitrate, accelerates sedimentation. The reason for this is (1) the electrostatic attraction between the colloids and the ions carrying the opposite electrical charge; (2) the removal of the water of the colloid. Hygroscopic electrolytes are, therefore, particularly efficient. Colloidal clay absorbs aniline dyes such as methylene blue. By absorption we understand the concentration of a dissolved salt on a surface due to difference in surface tension or electric potential. Clays also absorb and retail other substances, such as oils, fats, starch, proteins, certain inorganic dyes, all aniline and plant coloring matter, urine and fecal matter, putrid odors, and a large number of other substances. This property of absorption has led Professor Rohland, of Germany, to develop his clay treatment of sewage and industrial waste waters. Absorption is selective. An interesting study on this point has recently been made by Parker.

When applying methylene blue to waters carrying colloidal suspensions of clay, the dye is absorbed by the clay and sedimentation occurs, leaving the liquid colorless. The sediment is blue. This absorption may be only partial; it may take place quickly or slowly, all depending upon the quality and the character of the colloidal matter present. The absorption interferes seriously with the quantitative determination desired on the degree of putrescibility of the liquid. In other words, "relative stabilities" obtained in such waters by the methylene blue method cannot be correct. Spitta and Weldert, in their original communication, advise the observation of decolorization of the sediment after absorption takes place, though their observations are more of a qualitative nature and in such cases the exact time element is of less importance. In obtaining Phelps' "relative stabilities," the time element is all important.

*Read before the Laboratory Section American Public Health Association, Jacksonville, Fla.

Until recently the writer disregarded the decolorization of the liquid in polluted river waters, and accepted the decolorization of the sediment as the criterion. Correspondence between the writer and Dr. F. E. Hale, of the Mount Prospect laboratory, Brooklyn, N.Y., developed a difference of opinion regarding the reliability of this procedure. Doctor Hale held that the methylene blue once thrown out of solution is probably inert, and that, therefore, the decolorization of the liquid should be accepted as the sole index of the putrescibility. Doctor Hale's procedure consists in adding one cc. of methylene green solution at the beginning and continuously thereafter, as demanded by absorption, until a slight color persists in the liquid. Decolorization of this was taken as the endpoint. Doctor Hale considers that this method gives good relative results, but probably does not represent absolute values. The writer's aim was to obtain correct relative stabilities, while Doctor's Hale's procedure aimed at relative results. In this respect the problem differed. Notwithstanding, I decided to investigate whether the observation of the decolorization of the sediment actually furnishes correct relative stabilities, and if not, which procedure would have to be followed.

Jackson and Horton recommend the use of as little methylene blue as possible, on account of its antiseptic properties, and the writer, in investigating the quantities recommended in the "Standard Methods," fixed the amount at 0.4 cc. of a 0.05 per cent. aqueous solution per 150 cc. bottle capacity. When working with waters carrying colloids, it is clear, of course, that there should always be 0.4 cc. or less of the coloring matter in solution, provided the sediment containing the precipitated coloring matter is actually inert. An excess of coloring matter in solution would interfere with obtaining correct results. If the coloring matter in the sediment retains its antiseptic qualities, even though to a lesser degree, it would still be impossible to obtain correct figures. The entire question depends, of course, upon the value of all methylene blue or other similar "relative stabilities" when applied to liquids other than sprinkling filter effluents.

Since the decolorization of the blue color coincides fairly closely with the elimination of the total available oxygen, the writer first determined the oxygen at the time of decolorization of the liquid and sediment as well. An artificial turbidity of 100 was imparted to a putrescible sewage-water mixture and a number of glass stoppered

Table I.—Elimination of Available Oxygen in Turbid Waters on Applying the Methylene Blue Putrescibility Test.

Serial No.	Date and time 1914.	No. of cc. 0.05% methy. blue added per 150 cc. capacity.	Color of supernatant liquid in 24 hours.	Time of decolorization of liquid in hours.	Time of decolorization of sediment in hours.	P.P.M. total initial available oxygen.	P.P.M. residual oxygen at time of decolorization of liquid.
1	April 14	0.4	colorless	24	Sediment	23.3	10.5
	11.00 a.m.	0.8	colorless	24	did not	23.3	10.5
		1.2	colorless	24	decolorize in	23.3	—
		2.0	blue	blue after 10 days	10 days	23.3	—
2	April 15	0.4	colorless	24	Sediment	23.5	8.8
	10.30 a.m.	0.8	colorless	24	did not	23.5	8.8
		1.2	colorless	24	decolorize in	23.5	8.8
		2.0	blue	blue after 10 days	10 days	23.5	—
3	April 20	0.4	colorless	20*	88	20.1	0.5
	11.00 a.m.	0.8	colorless	20*	105	20.1	0.5
		1.2	colorless	20*	112	20.1	0.5
		2.0	slightly blue	45	119	20.1	0.4
4	April 23	0.4	colorless	24	Sediment	22.1	4.7
	11.00 a.m.	0.8	colorless	24	did not	22.1	4.7
		1.2	slightly blue	48	decolorize in	22.1	0.6
		2.0	slightly blue	93	10 days	22.1	0.5
5	April 27	0.4	colorless	20*	52	18.7	0.5
	11.00 a.m.	0.8	colorless	20*	61	18.7	0.5
		1.2	colorless	20*	70	18.7	0.5
		2.0	blue	45	76	18.7	0.4
6	April 29	0.4	colorless	20	100	21.0	2.9
	11.00 a.m.	0.8	colorless	20	118	21.0	2.9
		1.2	colorless	20	127	21.0	2.9
		2.0	blue	45	142	21.0	0.7
7	April 30	0.4	colorless	20	127	21.4	5.0
	11.00 a.m.	0.8		20	148	21.4	5.0
		1.2		20	169	21.4	5.0
		2.0		45	181	21.4	0.4

*Decolorized during the night, therefore estimated but roughly. The absence of the residual oxygen at the time of the decolorization of the liquid is of course due to the fact that the oxygen has not been determined at the exact time of decolorization.

bottles were filled with this liquid. A number of these bottles were colored in the proper proportion with methylene blue, the others remained as "blanks" for the determination of the residual available oxygen. The results are given in the accompanying Table I.

These tabulated results indicate the following conclusions: A very serious mistake can be made by assuming that the decolorization of the sediment in silt-bearing waters is the correct measure of the "relative stability." Experiments 3, 4, 5, 6 and 7 show that the decolorization lags far behind the elimination of the available oxygen in such liquids or, in other words, the methylene blue, once absorbed, is largely inert as an indicator. This bears out Doctor Hale's assumption. The absorbed liquid is, however, not entirely inert, as otherwise the sediment would never decolorize. The fact that the sediment decolorizes only under prolonged ultra-anærobic conditions makes such an observation useless for quantitative purposes. Reliance on the decolorization of the liquid is equally doubtful because we cannot tell to what extent the decolorization is really absorption. We can only be fairly certain of obtaining accurate "relative stabilities" if we knew that 0.4 cc. or less of the coloring matter per 150 cc. bottle capacity would remain in excess over the absorption requirements, and that the absorbed methylene blue was entirely inert. This cannot be insured under practical conditions, but remains a matter of chance. If more than 0.4 cc. of the coloring matter remains in solution, the antiseptic qualities of the dye would make itself felt and higher "relative stabilities" would result. The absorption of the coloring matter seems to bear a definite relation to the amount of colloidal matter present, and indeed some German observers have recommended a quantitative procedure for determining colloids on this basis. The Methylene blue test in waters carrying colloids is, therefore, of negative value only; *i.e.*, if the blue color of the liquid persists irrespective of absorption, the "relative stability" is 100, or an excess of oxygen may be present.

A number of coagulants, such as freshly precipitated aluminum hydrate, magnesium hydrate, calcium carbonate and calcium oxide were employed to mechanically settle the colloids previous to introducing the coloring matter. The results were not sufficiently encouraging to follow this line of experiment. The addition of electrolytes to sewage, such as common salt, did not accelerate the sedimentation sufficiently to be of practical advantage.

The writer is forced to conclude that it is useless to determine "relative stabilities in turbid waters by the methylene blue method. This is unfortunate, since it robs us of a simple and convenient field procedure. To obtain the correct oxygen demand in such waters, the following procedure is requisite:

Determining the initial available oxygen. The free oxygen has to be determined on the spot. A sample for nitrate and nitrate determination can be preserved with chloroform and shipped to the laboratory. Three other samples should be collected carefully to avoid aëration. To one sample add either a certain quantity of fresh water (free of nitrites and nitrates) with a known oxygen content or a definite quantity of saltpeter. Personally, the writer prefers to add saltpeter, since it is a much simpler procedure. The other two samples remain as originally collected. All of these samples are now incubated in closed bottles for ten days at 20° C. At the end of this incubation period, the residual available oxygen is determined in the samples devoid of saltpeter or additional water. The other sample is examined quantitatively for nitrites and nitrates. If free oxygen remains at the end of incubation the residual saltpeter oxygen need not be determined. All figures are referred to one litter of original river water. The nitrite nitrogen multiplied by 1.7 and the nitrate nitrogen multiplied by 2.9 express equivalents of oxygen. The initial available oxygen minus the residual oxygen expresses the biochemical oxygen demand. When the water is very badly polluted, the free oxygen sample need not be incubated for the reason that the free oxygen is certain to be absent after incubation. In connection with these incubations, it is important to keep in mind that the nitrites and nitrates are attacked while free oxygen is still present. As a rule, the nitrites and nitrates begin to be attacked when the free oxygen content is reduced by about 50 per cent.

THE RAIN-GAUGE IN RAINFALL COMPUTATIONS.*

By E. A. Lees,
Birmingham Water Department.

THE basis of any method of computation is the rain-gauge, and this it is quite unnecessary to describe, premising only that it is of approved pattern and of sufficient capacity. It must, however, be remarked that the rain-gauge furnishes a record simply of the rain which finds its way into the gauge glass, and that such record is not of necessity and by itself a record of the actual rainfall of any particular area, and in order to constitute the rain-gauge a record of the actual precipitation, even in its immediate vicinity, it is necessary that it shall be located and fixed with the utmost care in view of the surrounding conditions.

Assuming the rain-gauge to be so constructed and placed that it shall correctly record the precipitation in its immediate vicinity, the next question which arises is, to what area can the rainfall so ascertained be properly applied? And it will be apparent that the fact that a number of gauges distributed over a tract of country yield varying results involves the limitation of the area to which each record applies.

A common way of computing the total precipitation over an area is by establishing a number of rain-gauges within the area and making an arithmetical mean of their records, applying that figure to the total area.

Assume, for instance, an area of 10,000 acres on which four rain-gauges are established giving records of 25, 27, 29 and 31 in. per annum, respectively. The arithmetical average of the four gauges is 28 in., and applying the factor of 22,600 gallons per inch of rain per acre, we have a total rainfall for the area of 6,328 million gallons. It is evident, however, that this method assumes that the record of each of the several gauges applies to an equal area. In practice this will not be the case, and it might easily be that the reading of the 25-in. gauge applied to half the area, the 27-in. to one-quarter, and the 29 in. and 31-in. records to one-eighth each. Under these conditions the total precipitation on the area would be 6,045 million gallons, an appreciable reduction. Conversely, if one assumed a larger proportion of area for the higher readings, the computation for the whole area would be correspondingly greater.

*From a paper read at the 4th annual meeting of the Municipal Waterworks Association, held at London, October 1st, 1915.

In practice the location of the rain-gauges would be selected according to the conformation of the country, so as to secure such a proportion of higher or lower records as to bring the arithmetical mean roughly into accord with the physical facts. It is clear, however, that the only method by which an arithmetical average can be made to approximate reasonably to the actual rainfall for the whole area would be the provision of so large a number of gauges that the effect of the differences in area to which their readings applied should be eliminated. The objection to this would be the cost of providing and maintaining the gauges and of obtaining the readings.

Another and more scientific method is to use the readings of rain-gauges, not as direct indications of precipitation, but as elements in a calculation whereby areas of equal rainfall may be determined. This is achieved by the plotting of isohyetal lines on a map of the area. It may be explained that by an isohyetal line is meant a line passing through points having the same rainfall for the period under review, say, a year. Such lines are determined by means of all the available data, using for the purpose the readings not only of the rain-gauges established in the specific area under consideration, but also those over a large tract of surrounding country. By the utilization of these data, and comparing the reading of one gauge with another, lines along which the precipitation is uniform can be determined, and provided that the isohyetal lines are sufficiently close to each other, it is a safe inference to apply to the area enclosed by any two of them a mean value of precipitation, and so arrive at the total rainfall for the period with much greater accuracy than by the application of an arithmetical average of the gauge records.

It must, however, be noted that the drawing of isohyetal lines is not accomplished merely by the mechanical process of linking up on the map gauges showing similar records, but is a process requiring great judgment, mature experience, and attention to the natural configuration of the district. One of the advantages of the isohyetal method is that it attracts attention to anomalous readings, and enables errors to be detected.

It must be recognized that by a different locating of rain-gauges the records might, on arithmetical average, have given a higher value than on the isohyetal method. In such a case the assumed rainfall would exceed the facts, and an error in this direction might easily entail serious consequences by leading to exaggerated anticipations of yield.

It may be asked, what useful purpose can be served by these observations. The answer, in the case of Birmingham, is, as indicated above, that, as a portion only of the ultimate scheme of reservoirs has been constructed, the question of available rainfall will clearly be an important element, not only in finally deciding the capacity of future reservoirs, but also in determining the date on which they must be provided; for it is clear that, if more rain than had been assumed can safely be expected in the summer months, when there would be available capacity to store it (and if there were not, it would follow that the reservoirs were already full), the date for the construction of further reservoirs could be somewhat deferred. Similar considerations to these would apply in the case of all partially-developed gathering grounds. It is, however, taking too narrow a view of a question of this kind to confine it to considerations of immediate and local utility, and the writer is quite sure that all of the members of the Municipal Waterworks Association share with him the opinion that the collection and careful collation of hydrographic statistics for the whole country is of great national importance.

The establishment of rain-gauges, and the keeping of records, are carried out by most water undertakings. There have, however, been cases where rain-gauges have been discontinued on the completion of works on the ground that they were not longer of any practical service. Even if this be true as regards a particular undertaking, it is manifest from what has already been written that returns of rain-gauges in one district furnish valuable data for the laying down of isohyetal lines beyond such district, and as all water undertakings have benefited by information previously ascertained, collected and collated, some return for the benefit received should be made towards the common stock of knowledge on the subject. The object to be aimed at is to obtain a continuous record of rainfall observations covering the country, so as to enable isohyetal lines to be plotted for every district.

In the opinion of the writer it should be made a statutory obligation on all water undertakings and local authorities generally to establish and maintain properly-located rain and stream gauges, and to make them available for national purposes.

WEST VANCOUVER WATER SUPPLY.

This municipality has under way an important water scheme, work upon which is to proceed without delay. A contract was awarded a few weeks ago to Mr. M. P. Cotton, the amount of it ($90,000) indicating that the project is of considerable size. The scheme provides for the installation of a reinforced concrete reservoir of 230,000 gallons capacity, and served through a settling tank by a 6-inch wood pipe line from an intake in Sisters Creek. The reservoir will be 16 feet deep and about 50 feet in diameter. The undertaking has been contemplated since 1912, when the municipality first faced the problem of obtaining a pure and adequate supply. Engineers investigating the available sources recommended a supply from Cypress Creek for the western section of the municipality and Sisters Creek and Capilano River as sources of supply for the eastern section. Last year, however, new plans were prepared covering the whole of the eastern district, and making provision for a supply from Sisters Creek. The cost was estimated at about $150,000, and the by-law was carried through. Tenders were called and the offers ranged from $98,000 to $120,000. The contract was awarded to a Vancouver firm which undertook to accept bonds for $98,000. It was found, however, that the bonds could not, at that time, be sold and the contract had, therefore, to be cancelled.

The council then decided to reduce the cost by the substitution of wood for steel pipes, and the elimination of the dam at Sisters Creek. It was proposed to have an intake and pipe the water through a settling tank to a 230,000-gallon reservoir or tank without making any change in the previously proposed distribution of the water.

The scheme, as finally adopted, involves about 18 miles of wood pipe, 6 inches in diameter. The contract provides for completion next spring.

Editorial

COMMUNION OF ENGINEERS.

One of the most prominent weaknesses of the engineering profession is the need of communion among its members. Other professions and also many crafts have established communion for their own benefit and for the protection of the public. It is not absolutely necessary that engineering should be a closed profession for this purpose. Engineers, by the nature of their calling, tend to isolation; their duty often entails a more or less prolonged absence from the company of their confreres. Engineering as a distinct and recognized profession, is a comparatively recent development, although individually, engineers have done much for the public for centuries past. Still, they have their representative organizations in different parts of the world, and are loyal to them, although we must recognize the fact that passive loyalty has not the same value as active co-operation.

A representative organization must necessarily be a reflex of the attitude of its members. A vigorous constitution is seldom found in a languid body. Likewise if members desire to see something tangible and enterprising done by their institution it must be done by themselves or, more correctly, they must see that their representatives are embued with similar desires.

The Canadian Society of Civil Engineers is the premier organization of the Dominion, and as such, all engineers in this country naturally desire to see it occupy the position it deserves and should demand in the organized life of Canada. If it does not attain the eminence wished for by the members, the fault lies with themselves. The Canadian Society of Civil Engineers has over 3,000 members of all classes, who are engaged on all branches of engineering works. Excellent papers are read at the meetings, but the contributions to the discussions are very limited. If this Society is to fulfil the primary function of its existence, which is to disseminate knowledge, that can only be done by communion among engineers; by a steadfast determination that the Society shall be supported by the united efforts of its members to exchange information on engineering subjects.

It is the experience of engineers that counts in life's work, and no two engineers meet with similar experience, neither do they apply established principles in the same manner, otherwise individualism would be lost and engineering would become more mechanical than mental exercise of judgment. If, then, engineers gain different experience, its value is extremely limited if it is to be hidden in obscurity. The value of experience lies in publicity. For example, if the knowledge gained by experience of sewage treatment, water purification, reinforced concrete construction, and so on, were to be locked up in individuals and denied their confreres, there would be very little progress. We hope no engineer has descended to the level of the secretive miser whose hoarded treasures were not available during his life and could not be found when he died; nor do we believe there is an engineer like Mr. Tite Barnacle, whom Dickens describes as always a "buttoned-up man" lest his information might evaporate and his personal value depreciate. We prefer to think of engineers whose fund of knowledge increases as they impart it to others.

One reason why the remarkable strength of mortar used by the Romans is a forgotten mixture is due to the fact that the information was not imparted to others. It is acknowledged by all engineers that to-day we must rely on co-operation in order that the profession shall not only be abreast of the times, but maintain a slight lead. We can all lag behind if we so chose, but the sentiment is assuredly to be in the van; and to do this, each member must give of his best, and give freely of his own volition, in the belief that by so doing, however humble and insignificant the service may be, he contributes something which may not only confer an inestimable boon on his fellows, but also redounds to his own credit and increases the measure of confidence in himself and others.

Lastly, the Canadian Society of Civil Engineers has just issued its list of nominees for officers and members of the Council for the year 1916. These are the men who are to administer the affairs of the Society next year, and as such we firmly believe that not one of them would resent being out-voted by better men, supposing such were to be found. These men appreciate the honor of representing their fellow engineers exactly in proportion to the confidence which is reposed in them. To be elected simply on the nomination of the committee without a tangible expression of confidence from the members at large is not comparable with an emphatic confirmation of the committee's selection on the part of the members.

CANADIAN OVERSEAS RAILWAY CONSTRUCTION CORPS.

As announced in a recent issue, the Canadian Overseas Railway Construction Corps returned to England from the Belgian front and encamped at Longmoor, Hampshire, Eng., prior to departing for one of the eastern lines of battle. It will be remembered that the formation of this special corps was the result of a request from the British Government to the Canadian Government for a corps of railway experts. The request was handed over to the Canadian Pacific Railway, and Mr. G. J. Bury, vice-president, at once took the matter up. He called for 500 men, and the applicants who came from all parts of Canada—from Halifax to Vancouver—numbered 5,000. Of the men selected the majority were Canadian Pacific Railway men; but the Grand Trunk Pacific and the Canadian Northern also supplied men. The selected men were bridge designers, civil engineers, construction experts, and so forth. Not a man was taken who was not highly trained. The Canadian Pacific Railway furnished the officers, and Colonel C. W. P. Ramsay, who had charge of the construction of the Eastern lines of the Canadian Pacific Railway, was given the command, while Mr. F. L. Wanklyn was made honorary colonel. Recruiting was started in March, and the corps was completed and equipped by May. It went over to England with 1,000 tons of construction plant in June, and went to Belgium in August. On the way across the corps had a narrow escape from a torpedo, as a freighter which was following the transport was struck and sunk.

The principal work of the corps in Belgium was the building of a narrow-gauge railway behind the first line of trenches extending the whole length of the Belgium front. The train is drawn by a seven-foot gasoline engine, the cars being just over three feet high. Everything is painted the color of the earth, and when a German flare lights up the locality the train comes to a sudden stop and is practically invisible. By this train, food and munitions and everything needed in the trenches is conveyed during the night. One section the Canadians built is over flat country five miles in extent, and they were much exposed to shell fire, but as they only work at night the casualties were few.

The corps was also engaged in the construction of concrete emplacements for guns in the trenches, and these had been so strongly constructed that when the Allied drive took place the Germans shelled vigorously the Belgian lines, as a counterstroke, but the concrete and steel hoods, covered with loose earth and boulders, withstood all the explosives that were hurled against it, and as the machine-guns covered every possible avenue of approach the Germans had no chance of reaching the Allied lines.

It is of interest to note that while in England the corps was inspected by the King, who said that physically it was one of the finest bodies of men he had seen. The corps is the highest paid corps in the army. Privates get $2.90 a day (regimental and working pay) and a separation allowance of $20 a month.

Capt. H. Wellwood and Sergt.-Major Wood, members of the organization, are back in Canada at the present time to obtain 120 more qualified men to reinforce the original corps.

LETTER TO THE EDITOR.

"A Light and Useful Roof Truss."

Sir,—I have read with much interest Mr. Darling's criticism of the article which appeared in your issue of October 14th, entitled "A Light and Useful Roof Truss." The article was intended to describe a particular design of roof principal which I believed would suit many structures where more elaborate and costly designs are often used. I did not claim for the truss that it was a universal stand-by to be adopted indiscriminately, but simply what Mr. Darling himself concedes in his last paragraph, "that it has a place in construction, and that its utility and economy depend upon circumstances," which a designer should take into account.

Mr. Darling's criticisms may be briefly classified under two heads—those referring to certain local conditions affecting the use of this type of principal, and those applying to certain details of the design. With regard to the former, I agree with him that where a snow storm of such severity as he describes is a probability it should not be ignored, and I should expect an engineer to design accordingly, and provide tension and compression members to resist it. In the Prairie Provinces, where the snow is fine and dry, and never moistened by rain, a snow load of over 30 lbs. per square foot would be a superfluous provision and an unnecessary expense.

With regard to his criticisms of design, the distinct members in the truss are the string, the bow, and the lattices. Mr. Darling finds no material fault with the string, except that it is stronger than strong enough. The lattices pass unnoticed, so that I may assume we are in agreement regarding them. It can only be of the bow that he is thinking when using the term "skinned." As pointed out in my article, the roof load is applied to the principal at a great number of points where the ends of the lattices project above the bow, and fit accurately against the sides of the purlins, thus distributing the compression, which otherwise would have to be taken care of by the bow alone.

I think it best to omit any reference to the purlins, as they are to be found in every roof whether of wood or steel, and any discussion of them would only carry our thoughts from the real points at issue.

JAMES HAMILTON.

Edmonton, November 7th, 1915.

IMPROVED ROADS IN YORK TOWNSHIP, ONT.

According to E. A. James, C.E., engineer for the York County Highways Commission, there are 110 miles in the good roads system of South York. This mileage is spread over ten highways, radiating from the city of Toronto. These highways form the connecting link between the good roads system of Peel, Simcoe, North York and Ontario counties with the city of Toronto. Seventy-six miles of the system have been completed. Forty-two thousand dollars has been spent in culverts and bridges. Five hundred and fifty thousand dollars has been spent in highways.

The types of roads are: Brick, ½ mile; concrete, 2¼ miles; bituminous-bound macadam, 5½ miles; trap water-bound macadam, 2 miles; granite water-bound macadam, 18 miles; limestone water-bound macadam, 44¾ miles; gravel, 3 miles. Total, 76 miles.

In 1915, 12 miles were treated with tarvia, and over 45 miles oiled with an asphaltic oil.

The completed mileage on the various roads is as follows: Kingston Road, 6¾ miles; Kennedy Road, 13 miles; Markham Road, 3½ miles; Don Mills Road, 7¼ miles; Yonge Street, 13½ miles; Vaughan Road, 10½ miles; Weston Road, 13 miles; Malton Road, 1 mile; Dundas Street, 5½ miles; Lake Shore Road, 2¼ miles. Total, 76 miles.

NEW TYPE OF CULVERT FORM.

A description has been received of a new type of collapsible form for use in the construction of various sizes and types of culverts for concrete highways. It is built in but one size, but is adaptable to use in culverts of from 15 inches to 6 feet in width, with either arch, semi-arch or flat top. The form consists of four sections with arch tops, and is 24 feet long in all, 24 inches wide, and 27 inches high. It is equipped with two head walls, each being 48 in. x 84 in.; one set of wing walls; one parapet box; six cover plates, each being 2 ft. x 3 ft. To build culverts wider than 24 inches is accomplished by twinning two sections. The cover plates are placed across the arch tops, resulting in a culvert with a semi-arch top. Culverts may be built by the use of the arch tops alone, and have twice the carrying capacity of a 12-inch pipe with the same head room. A volume of water which would fill a 12-inch pipe would have a water level of about 4½ inches in the concrete culvert with ample allowance for flooded conditions.

This information regarding the Whalen form, as it is called, is from the manufacturers, the Concrete Form Company of Syracuse, N.Y.

COAST TO COAST

Coquahalla, B.C.—The last rail of the Kettle Valley Railway will be laid this month, according to a recent report by Mr. J. J. Warren, president of the road. Construction work on the final section is practically completed.

Saanich, B.C.—A part of the new waterworks system will be ready for service by the end of this month. A junction has been made with the Sooke Lake water supply system, and some 600 service connections will be supplying water in the course of a month.

Vancouver, B.C.—Mr. J. W. Stewart, president of the Pacific Great Eastern Railway, has returned from Europe, and the question of expediting further construction work is being dealt with. Some extensive bridge and track work in the vicinity of Clinton is at present under way.

Brantford, Ont.—Overhead work is now complete between Brantford and Galt on the Lake Erie and Northern Railway. From Brantford south poles are now being distributed. Several new stations have been erected, and, taken altogether, excellent progress is being made with the work.

Montreal, Que.—The bursting of a 36-inch water main caused considerable damage at the corner of Windsor and St. Antoine Streets, and released about 500,000 gallons of water from the McTavish Street reservoir. The pipe was installed in 1908. At time of writing a complete investigation of the fracture had not been made and no official report as to the cause of the accident was obtainable.

Hamilton, Ont.—The Grand Trunk Railway is installing a switch siding at Windmill Point, Ont., to be used by the Coast and Lake Contracting Corporation, Limited, quarries, thereby enabling this company to ship by both rail and water hereafter. A crusher has been installed on the quarry site for the manufacture of crusher run stone in large quantities. This quarry was formerly operated by the Hughes Bros. and Bangs twenty years ago.

Victoria, B.C.—It is announced that the Canadian Northern Pacific Railway is to resume construction work on the Vancouver Island sections of the system, and that before the close of the year a section of the west coast line will be completed to tide water. Temporary terminal facilities will be constructed on the Songhees Indian Reserve. The line to Patricia Bay, which is completely graded, with culverts and bridges ready for track laying, will also be completed without delay.

Edmonton, Alta.—The projected railway from Athabasca to Fort Vermilion on the Peace River has been completely surveyed this season, and reports are now being completed. Construction has commenced on steamers and terminals for a ferry line between Peace River Crossing and Fort Vermilion. Tramways are under construction at Smith Rapids and Vermilion chutes. At the latter point boring operations for gas and oil are under way and it is reported that the indications are very satisfactory. The D. A. Thomas' interests, which are behind the railway, claim that they have in the north one of the world's greatest potash beds.

Montreal, Que.—City Engineer Paul E. Mercier returns from the Dayton convention of the American Society of Municipal Improvements much impressed with the dry cleaning method of keeping paved streets in order. Its adoption in many cities of the United States, and its numerous supporters among city engineers generally have made it a subject of considerable interest. Dry cleaning is preferred because it is cheaper and because it obviates the slipperiness of wet pavements. It is of interest to recall here the statements of Mr. C. H. Rust, city engineer of Vancouver, whose figures for last year show a cost of only 16½ cents per thousand square yards.

Quebec, Que.—It is expected that the Provincial Government will undertake the construction of an improved highway between Shawinigan Falls, Grand Mere and Three Rivers. A party, including Hon. J. A. Tessier, minister of roads; Mr. Ben. Michaud, deputy minister of roads; Mr. Gabriel Henry, chief engineer of the roads department, and a number of others, went over the route last week. Five large concerns, *viz.*, the Shawinigan Water and Power Co., the Belgo-Canadian Pulp and Paper Co., the Laurentide Pulp and Paper Co., the Canada Carbide Co., and the Northern Aluminum Co., have already invested a capital of nearly $25,000,000 in the industrial centres of Shawinigan Falls and Grand Mere. The towns are growing rapidly and they all need badly a good road to connect them with Three Rivers and Montreal and Quebec, by the way of the new Montreal-Quebec road, which is almost finished.

Edmonton, Alta.—Since the discovery of natural gas at Viking last year, and the consequent proof of the existence of gas fields adjacent to Edmonton, the city council has given earnest consideration to the question of providing a supply of the gas within the city for industrial, municipal, and domestic use, the proposal being to construct a pipe line from one of the proven fields, or to prospect certain probable fields in closer proximity. A by-law proposing to empower the council to expend $30,000 on exploration work was recently defeated by a vote of the burgesses, since when several private concerns have entered into negotiation with the council with a view to obtain a franchise. At a special meeting held on October 12th, 1915, the council endorsed the offer of the Northern Alberta Natural Gas Development Company, Limited, and ordered that an agreement between the council and the company, on the basis of a twenty-year franchise, be submitted to the burgesses on November 8th next. Unsuccessful offers were made by Mr. J. D. McArthur, Mr. C. B. Reilly, Messrs. Parlee, Freeman and Abbott, the Mount Allison Oil and Asphalt Company, Limited, and the Great Northern Oil and Asphalte Company, Limited.

PERSONAL.

Lieut. F. ALPORT, of the Sixth Field Company, Canadian Engineers, 1st Canadian Contingent, has been reported wounded.

FRANK CHAPPELL, town engineer of Oshawa, Ont., has resigned, having secured an appointment with the McLaughlin Automobile Company of Oshawa.

W. R. DEVENISH, assistant chief engineer of the Intercolonial Railway, has been appointed district superintendent at Campbellton, succeeding the late Mr. Evan Price.

STEPHEN A. PAYNE has been promoted to fill the vacancy in the staff of the Dominion Department of Public Works at St. John, N.B., caused by the death of Mr. Thomas H. Adams.

ARTHUR MacNAMARA, formerly assistant to the superintendent of motive power for the Grand Trunk Pacific at Transcona, has been appointed provincial factory inspector for Manitoba.

HUGH WALKEN, resident engineer for the Canadian Pacific Railway at Nelson, B.C., for the past year, has been transferred to the staff of the division engineer at Vancouver. His position at Nelson is now being filled by Mr. H. C. Barber, formerly in charge of tunnelling operations at Roger's Pass.

R. F. HAYWARD, chairman of the Vancouver Branch of the Canadian Society of Civil Engineers, gave an instructive illustrated lecture on the plant of the Mexican Light and Power Co. at a recent joint meeting of the Vancouver Branch of the Society and the Vancouver section of the American Institute of Electrical Engineers.

GEORGE E. GRAHAM, who succeeds Mr. P. Gifkin as general manager of the Dominion Atlantic Railway, has been in the employ of the Canadian Pacific Railway since 1888. In 1901 he became superintendent of weighing at Montreal; in 1905 superintendent of terminals at Winnipeg; superintendent at Fort William in 1908. In 1910 he was transferred to Vancouver as superintendent.

A. E. GRANT, president and managing director of the Canadian British Insulated Co., sailed for England last week on the "Adriatic." His company, which was a branch of the British Insulated & Helsby Cables, has withdrawn from the Canadian field on account of the War Office and Admiralty requiring the entire output of their works in England. They had no Canadian factory. Their interests in Canada, concerning guarantees, maintenance, etc., will be attended to for the time being by Lawford Grant, Montreal.

OBITUARY.

Information has been received from Vancouver, B.C., of the death of Mr. William Snider, for fifteen years road commissioner of Vancouver Island. The deceased was well known in British Columbia as a road builder and contractor, many of the trunk and municipal roads surrounding Vancouver and Victoria having been constructed by him.

The death occurred in Vancouver last week of Mr. Henry W. Kensit, a civil engineer who has been a resident of that city for the past eight years, and who has been with the Canadian Northern Pacific Railway for the past three years.

The death occurred in Toronto a few days ago of Mr. W. H. Kennedy in his ninetieth year. The deceased was for many years a well-known mechanical engineer in Toronto.

The death occurred in Guelph on October 28th of Mr. Richard Mahoney, engineer and contractor. The deceased had been a resident of Guelph since 1862, and in that city he has been closely connected with building operations since that time. For some years he was engaged in railway work and assisted in the construction of what was then known as the Great Western Railway between Toronto and Niagara Falls.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

Annual Excursion to the Welland Ship Canal.

Through the kindness of Mr. J. L. Weller, chief engineer of the New Welland Ship Canal, upwards of 200 members of the Toronto Branch of the Canadian Society of Civil Engineers were escorted over the northern portion of the canal work on Friday, November 5th. The party, under the direction of Messrs. J. R. W. Ambrose and C. H. R. Fuller, chairman and secretary respectively of the Branch, was divided into small groups with an engineer of the canal staff in charge of each. Every part of sections 1, 2 and 3 was inspected, the chief engineering features pertaining thereto being ably described and explained by the engineers in charge. The tour of inspection was directed northward from Thorold to Port Weller, the party proceeding on foot over all the chief centres of present construction activity and advanced work, and by rail along the bank of the canal from one section to another. Lunch, more properly called a feast, was served at one of the camps at noon, while in the evening the party dined in St. Catharines.

The progress made since October 31st, 1914, when a similar trip was made by the Branch, was a surprise to many, and the enormity of the undertaking a revelation of constantly increasing degree. A brief description of the development that has taken place during the past year appears elsewhere in this issue.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The regular meeting on November 4th, held at the Society's headquarters in Montreal, was the first of a series of meetings devoted to a description and discussion of the development and construction of the hydro-electric plant of the Cedars Rapids Power and Manufacturing Co. The general features of the project were discussed at Thursday's meeting by Mr. Henry Holgate, M.Can. Soc.C.E.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.—Annual convention to be held at Dayton, Ohio, November 17th to 19th. Secretary, Clinton Rogers Woodruff, 705 North American Building, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Annual meeting to be held at New York December 7th to 10th. Secretary, Calvin W. Rice, 29 W. 39th Street, New York.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Fourteenth annual convention to be held at Toronto January 18th to 20th, 1916. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

We have had made up on stiff cards for handy reference purposes the Charts for Specific Speed and Diameter of Hydraulic Turbines by R. L. Hearn, B.A.Sc., which were published in our issue of October 21st, 1915. Those interested in these tables may secure a copy by applying to the office of The Canadian Engineer.