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January-June, 1916

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The Canadian Engineer

A weekly paper for civil engineers and contractors

NEW OCEAN TERMINALS AT HALIFAX, N. S.

FIRST OF A SERIES OF ARTICLES DESCRIPTIVE OF ONE OF CANADA'S GREATEST ENGINEERING UNDERTAKINGS FOR THE IMPROVEMENT OF HER OCEAN COMMERCE—A $35,000,000 TERMINAL.

By LIEUT. T. W. J. LYNCH,
Formerly Assistant Engineer, City of Halifax.

At present Halifax is served by two terminals, one at Richmond, in the extreme northern section of the city and the other, the so-called "Deep Water Terminals," located more centrally, off Water Street, south of H.M. naval yard. A few years ago (1912) it was decided to construct large new ocean terminals, to be located considerably farther out in the harbor, at George's Island Bay, near the south or ocean end of the peninsula on which the city is located. The Minister of Railways and Canals for Canada accordingly instructed Mr. F. P. Gutelius, M.Can.Soc.C.E., now General Manager, Canadian Government Railways, and Mr. F. W. Cowie, M.Can.Soc.C.E., Chief Engineer, Montreal Harbor Commission, to prepare the comprehensive scheme which underlies the present constructional activities of which the following is descriptive.

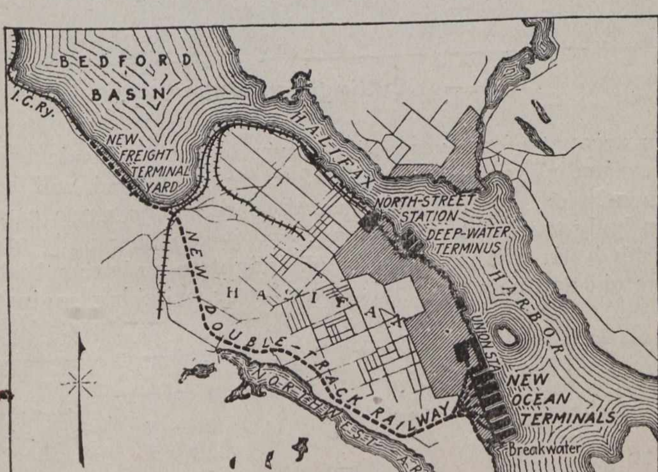


Fig. 1.—Map of Halifax, Showing Location of the New Terminals.

The terminals, which have been designed to be the best equipped on the Atlantic coast, will consist of a bulkhead passenger landing quay, or wharf, 2,006 ft. long with 45 ft. depth of water at low water of spring tides, at which three of the largest ocean steamers can dock at the same time in safety and without tug assistance; a wharf building the whole length of the bulkhead quay, the first floor of which will be for freight and the second floor for passengers, customs and immigration quarters; also passenger and freight tracks that will run alongside the ships. The whole is laid out so as to give the most expeditious, convenient and economical arrangements for the transfer of passengers, baggage, mails and freight from steamer to rail and vice versâ.

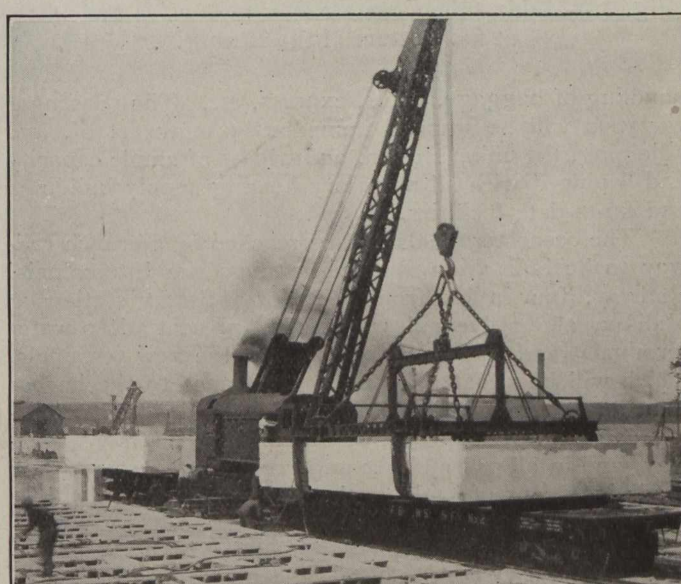


Fig. 2.—Moving the Finished Block.

This scheme of development provides for the construction of five piers, 1,250 ft. long and from 320 to 360 ft. wide, equipped with wharf freight sheds and railway tracks; of railway yards for the storage and switching of cars; of elevators which will permit of grain being loaded into ships at each of 20 berths; of a central light, heat and power plant, and a locomotive house for switching engines; parlor, sleeping and dining car department and passenger coach yard, etc., and of a breakwater from Pt. Pleasant Park to the Reid Rock Buoy, about 1,600 ft. long in deep water.

The first unit will consist of the bulkhead quay with freight sheds and immigration buildings, passenger station and one pier equipped with sheds and tracks, together with all necessary accessories. This unit will provide accommodation for nine of the largest ocean steamships. As soon as business warrants it, more piers will be constructed, each giving an additional capacity for four such steamships. In the near future, perhaps upon the opening of the Quebec bridge, provision will have to be made for further accommodation.

The union passenger station which will be built near the corner of Hollis and South Streets, will be a very handsome and substantial structure, provided with all modern conveniences and facilities for passengers and the handling of baggage, mails, express, etc. The passenger car yard will be situated immediately southeast of, and adjoining, the union station, and will be of ample capacity and equipped with all necessary heating supply buildings and up-to-date facilities.

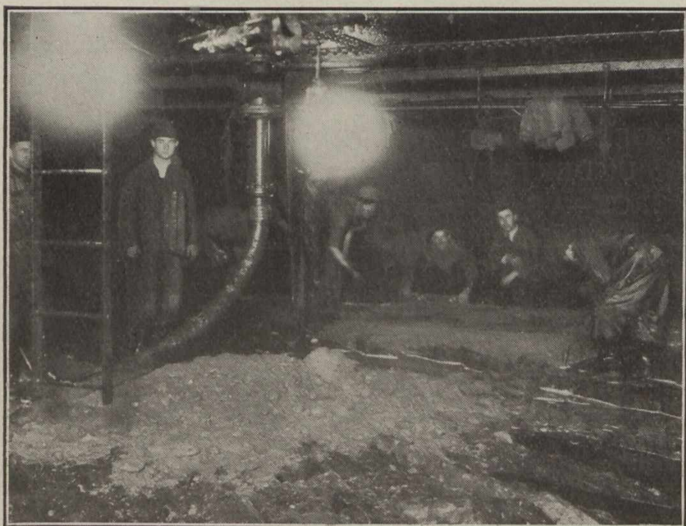


Fig. 3.—Making the Concrete Pier to Receive the Block at the Bottom of the Harbor.

The ocean terminals will be reached by a branch railway to be built from Rockingham, on the Intercolonial Railway, four miles from the North Street station at Halifax, about five miles from the present deep-water terminals and about six miles from the new terminals, which will be situated nearer the entrance to the harbor than any existing wharf. There will be no grade crossings, the railway being carried under the H. & S.W. Railway, and in all cases either under or over all streets and roads by means of bridges, the designs for which will be made to harmonize with their surroundings.

The railway has been designed for high-speed passenger and heavy freight trains. The maximum curvature will be 4 degrees and all curves will be laid out with suitable easements. The maximum gradient will be 0.6 per cent., compensated 0.04 per cent. per degree of curvature. To preserve the appearance of the residential section of Halifax along the northwest arm and in the vicinity of Pt. Pleasant Park, the railway will be constructed from Quinpool Road to Young Avenue in a cutting of sufficient depth to give clearance for the railway under the overhead bridges, which will carry the streets and roads over the railway. The line will be double tracked throughout, with additional lead tracks at the yards and terminals. The bridges, culverts and structures will all be of permanent construction. The excavations for the railway, which will greatly exceed the embankments, will consist mostly of rock. The surplus excavations from the northern end of the railway will fill in and reclaim from Bedford Basin a large and comparatively shallow area, which will be used for the new freight terminal yard. A suitable site for this yard would otherwise be very difficult to provide,

Fig. 4.—A Cutting Across the City.

on account of the very hilly nature of the peninsula and surrounding country. This new terminal yard will be open-ended and will have standing room for 1,000 cars on body tracks 4,000 ft. long, and it can be readily extended. It will take care of all freight to and from both the old and new terminals, transfer or switching engines

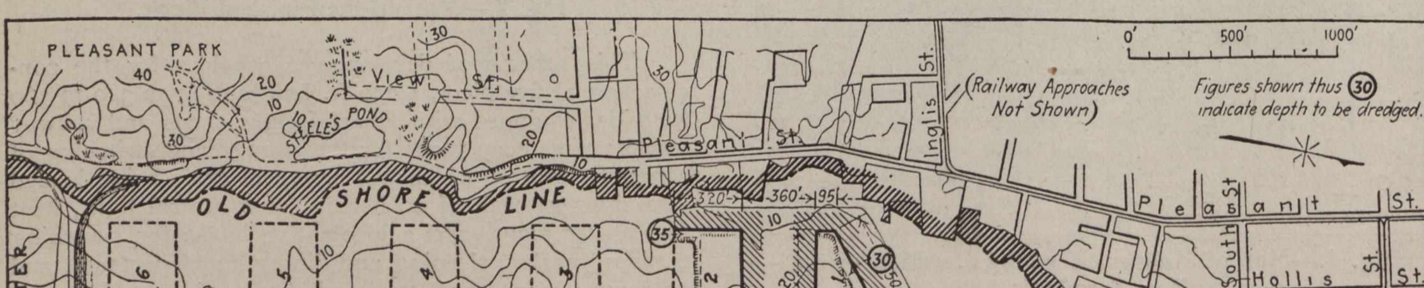


Fig. 5.—Layout of Quay and Piers and Location of Railway Terminal at Halifax. (*Drawing by courtesy Engineering News.*)

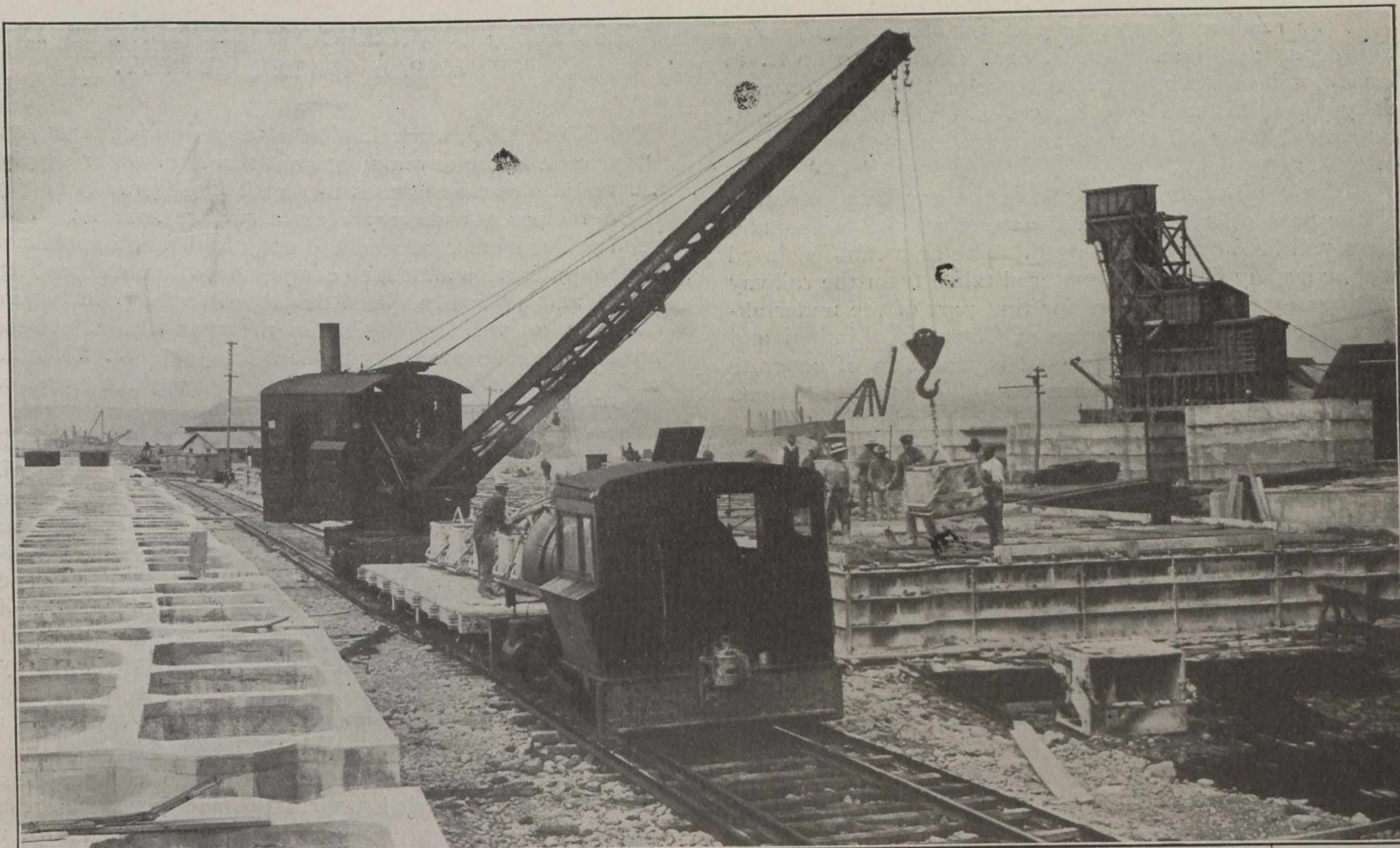


Fig. 6.—Filling the Forms with Concrete.

only being used between the new yard and the city and harbor terminals. The excess material from the railway cuttings at the southern end will be used for filling behind the quays and piers which are to be built in the harbor. Selected rock will also be obtained from the cuttings for the construction of the rubble mound breakwater, which will extend eastward into the harbor for about 1,600 ft.

The grading of the approach railway and the construction of the terminal yard at Bedford Basin and the breakwater at the harbor, the contracts for which were let to the Cook Construction Company, Limited, of Sudbury, Ont., and Andrew Wheaton, of Amherst, N.S., will be practically completed by the spring of 1916.

The estimated expenditures under the two contracts let are: (1) The Cook Construction Company, Limited, and Wheaton Brothers, for the grading of the railway and railway yards, including the breakwater, $1,750,000; (2) Foley Bros., Welch, Stewart and Fanquier, for quay walls, dredging, filling, shed foundations, sewers, etc., $5,500,000.

The whole scheme of terminals has been prepared under the direction and supervision of F. P. Gutelius, M.Can.Soc.C.E., General Manager, Canadian Government Railways; F. W. Cowie, M.Inst.C.E., Chief Engineer, Montreal Harbor Commission, is consulting engineer, and Jas. McGregor, A.M.Inst.C.E., to whom the writer is indebted for assistance in the preparation of this article, is superintending engineer in charge of the work at Halifax.

The deep-water terminals, now known as Pier 2,* have been completed as per contract and will be used for a year or two for passenger and freight purposes, until the ocean terminals are ready. The partitions and other interior fittings of the building will be removed and they will be used for freight purposes only.

Preliminary work was started at Fairview on the line of the new ocean terminals railway, July 31, 1913. The contractor's plant consists of five large steam shovels, electrically operated; fifty 12-yard air dump cars; four standard locomotives, and two Jordan air spreaders. The contract is being carried out jointly by a combination of the Cook Construction Company, Limited, Sudbury, Ont., and A. & W. D. Wheaton, Amherst, N.S.

On October 20th, 1915, Sir Robert Borden, Premier of the Dominion, and Hon. Frank Cochrane, Minister of Railways and Canals, assisted by other Dominion officials, visited the work and formally placed one of the 62½-ton concrete blocks in position in the quay wall. The ceremony was conducted amid immense dredges, scows, concrete mixers, cranes and other plant totalling in value over $1,000,000, which gave a distinct business tone to the event. A 100-ton crane gripped the block and swung it readily into place, while submarine blasting operations in the harbor added to the impressiveness of the agencies trained upon the work.

It is of interest to note that nine passenger steamships, as large as the "Alsatian," will be able to be alongside the quay walls when the present unit is completed and this space will be only one-third of the berthage room that will be provided when the whole undertaking is finished. A fleet of 27 ships, each as large as the "Alsatian," or any floating palace 600 ft. long, can then be accommodated at the piers at one and the same time. The northern portion of the unit, or passenger quay, will allow two "Mauretanias" to berth one ahead of the other. The ships thus provided for will have a depth of water alongside the piers of 45 ft. at low tide, New York having 40 ft. and Boston 35 ft. in the channel.

*For a description of the Halifax Deep Water Terminals see *The Canadian Engineer* for July 30th, 1914.

The reinforced concrete piles for the foundations of the depot and transit sheds, each from 40 to 60 ft. in length, will number 5,000. A force of 1,000 men, whose daily pay-roll is well over $2,000, with a similar expenditure per day for material, is an indication of the extent of present activities.

The quay walls running from the northern extremity of the passenger landing and around all the basins and piers will be 6,674 ft. in length. The area thus enclosed will be largely filled in by material taken from the railway cuttings by the contractors for that part of the undertaking, *i.e.*, the Cook Construction Company, Limited and Wheaton Bros. The quay wall is made up of concrete cellular blocks or shells, each weighing some 62½ tons

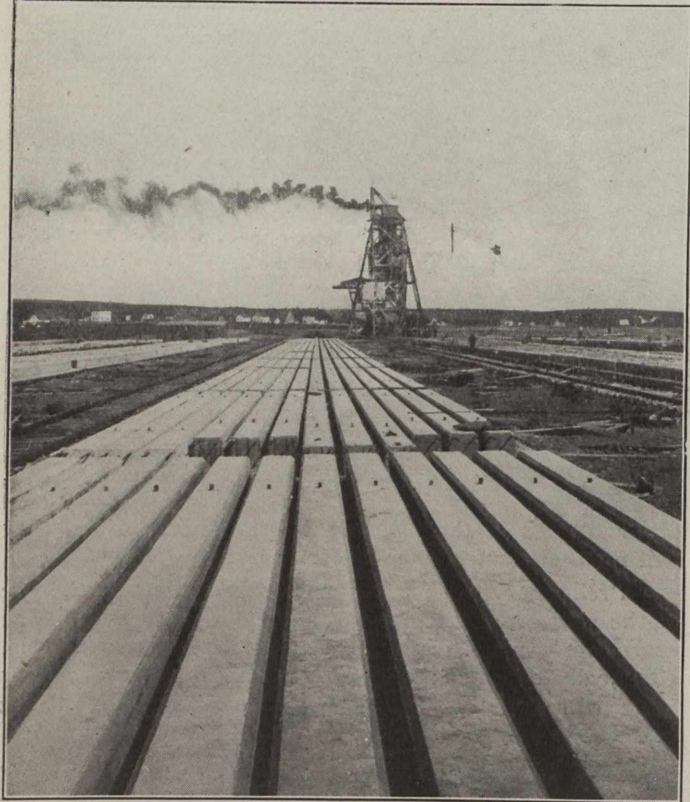


Fig. 7.—Making Reinforced Concrete Piles.

and faced from low-water mark up with granite. These shells are to be filled in with rubble and concrete, making a solid wall 31 ft. thick with a height of 60 ft., having a length of over 1¼ miles. The number of these concrete shells is 3,634, of which about 1,200 have been made and many are to be seen ready to be set in place. Their construction is illustrated in the accompanying views, and already about 350 have been placed in the quay walls, over 750 feet of which have been built.

The concrete in these shells will amount to 110,000 cubic yards and a similar amount of concrete will be required to fill them when placed. The total concrete in the walls will be approximately 260,000 cubic yards. Some 25,000,000 lbs. of steel reinforcing, 400,000 barrels of cement, and 300,000 cubic yards of gravel will be required. The cut granite facings for the quay walls will amount to 103,000 square feet. Extensive granite quarrying is being carried on for this undertaking in the Dominion Government quarries at Purcell's Cove at the mouth of the northwest arm.

An extensive freight tunnel system underlies practically every street in the downtown business district of Chicago, Ill., reducing surface vehicular traffic by one-third.

RECENT PROGRESS AND TENDENCIES IN MUNICIPAL WATER SUPPLY.

IMPORTANT work has been done during the past decade in the development of sources of water supply. Much interest attaches to recent large gravity supply developments of very remote surface sources. Two such projects of unprecedented magnitude and importance have been carried almost to completion within the past ten years, and a third has been developed to the point where construction will be possible in the near future. These projects receive especial mention in John W. Alvord's paper read at the International Engineering Congress, of which the following is an abstract.

The Catskill Supply.—The greatest single municipal water supply project so far undertaken is the Catskill supply for New York City. This project is designed to furnish 250,000,000 gallons per day as first completed, at a cost of about $200,000,000, and will be capable of enlargement to supply 500,000,000 gallons per day. The need for such a supply was foreseen as early as 1900, and led, after exhaustive investigations, to the beginning of construction in 1906. Impetus was given to the work by the drought and threatened water famine in 1911, and completion of the entire undertaking is now expected in about a year.

Los Angeles Aqueduct Supply.—The city of Los Angeles, in 1913, carried to virtual completion the largest single water supply project conceived and finished within the decade just past. This work, for boldness of conception and speed and economy of execution, is an excellent demonstration of the possibilities of municipal enterprise. When, in 1904, Los Angeles faced the prospect of outgrowing its municipally owned water supply of 40,000,000 gallons per day, the first definite steps were taken to secure an adequate supply for future needs. It was decided, after thorough investigation, to develop a gravity supply from Owens River, 250 miles distant, and construction of the great aqueduct began in 1907. This aqueduct, now completed, insures to the city 259,000,000 gallons per day of mountain water at a cost of $24,500,000, exclusive of power development. All water in excess of the city's present needs will be sold for irrigation and the great height of the source (3,812 feet) permits of several water power sites from which the city expects to derive additional revenue.

Hetch Hetchy Project.—The way has been paved during the past ten years to practically insure the construction in the near future of another great municipal water supply project, very similar to and rivalling in magnitude the Los Angeles aqueduct. This is the Hetch Hetchy project proposed for the future water supply of San Francisco and the adjourning bay cities. This project, as now planned, involves a gravity aqueduct 170 miles long, of 240,000,000 gallons per day present maximum capacity, and storage on the Tuolumne River sufficient to provide a present minimum supply during the driest year of 160,000,000 gallons per day, at an estimated cost of $36,981,000. The ultimate capacity of the project is to be 400,000,000 gallons per day, and the great altitude of the source (3,800 feet) makes possible three water power sites along the route of the aqueduct.

The chequered career of the Hetch Hetchy project is explained largely by the fact that San Francisco is supplied at present by a private water company, whose water supply resources are not as yet fully developed; that there are several other available sources of supply; that the proposed project must in part involve the development of

Table 1.—Growth in Population Supplied with Filtered Water in the United States by Slow Sand and by Rapid Sand Filters.

Year.	Total Urban Population in the U. S. (Towns and Cities above 2,500).	Pop. Supplied with Filtered Water. Slow Sand Filters.	Rapid Sand Filters.	Total.	Per Cent. of Urban Pop. Supplied. Slow Sand Filters.	Rapid Sand Filters.	Total.
1870 ...	....	None	None	0	0.00	0.00	0.00
1880 ...	13,300,000	30,000	None	30,000	0.23	0.00	0.23
1890 ...	21,400,000	35,000	275,000	310,000	.16	1.29	1.45
1900 ...	29,500,000	360,000	1,500,000	1,860,000	1.22	5.09	6.31
1904 ...	32,700,000	560,000	2,600,000	3,160,000	1.71	7.95	9.66
1910 ...	38,350,000	3,883,000	6,922,000	10,805,000	10.13	18.05	28.18
1914* ..	42,500,000	5,398,000	11,893,000	17,291,000	12.70	27.98	40.68

*Compiled January, 1914, by George A. Johnson.

a supply on government lands, and located in a National Park, and that the riparian rights of irrigation interests on the same river are involved.

Other Water Supply Developments.—The recent development of the larger supplies drawn from the Great Lakes has been influenced by the attempt to eliminate turbidity, and to secure more uniformly potable water by extending intakes to greater distances from the shore and to greater depths of water. Chicago, Milwaukee, Cleveland and Buffalo have attempted in this way to improve their supplies. Some benefit has been secured, but the remote intake does not insure pure water and does not give entire relief from turbidity at times of great storms. With the increasing pollution of the lakes, and the growing demand for pure, clear water at all times, the tendency of thought at present is towards the filtration of lake supplies. This tendency is shown by the use of filtration at Niagara Falls, N.Y.; Sandusky, Ohio; Erie, Pa.; and more recently at Evanston, Illinois; Cleveland, Ohio, and Toronto, Canada.

Many of our large cities continue to draw their water supply by pumping direct from near-by rivers, and the increase in quantity of water used from this source has been very considerable during the past ten years. The water supply problem for these cities has been greatly simplified by the present efficient methods of water purification, and practically all of our important river cities using river water have within the past ten years resorted to filtration. Among these cities are New Orleans, St. Louis, Minneapolis, Louisville, Evansville, Cincinnati, Pittsburgh, Philadelphia, Washington, and many smaller cities.

There have been many recent extensions of ground water supplies throughout the country, although the development of this source of supply has been advisable as a rule only in the smaller cities, and on a comparatively small scale. In some cases, as at La Crosse, Wis., a ground water supply has been developed, and the river supply abandoned to avoid filtration. In other cases, as at Des Moines, Ia., a satisfactory ground water supply has been extended, in preference to developing a river supply, with filtration. In still other instances, as in the case of the bay cities of California, ground water supplies have been extensively developed to supplement a very scant impounded supply, in a region where no rivers for water supply are available except at great distance.

With the continued growth of our urban population and the high rate of water consumption so characteristic of American cities, the problem of an adequate source of supply will continue to be a vital one for many of our cities, which are, as a rule, provided only for the immediate future, and will before many years, outgrow their present supplies. In certain sections of the country the limited water resources are without doubt a serious handicap to cities already existing, but where the growth of the city is sufficiently sustained we may expect to see other great water supply projects undertaken as at New York and Los Angeles.

Quality of Water for Municipal Supply.—Great improvement in the quality of the water furnished in many of our cities has been brought about during recent years by the introduction of supplies from pure sources and the purification of suspected supplies. The best general index we have of the extent to which our water supplies are better to-day than ten years ago, is still furnished by the typhoid fever death statistics, cautiously used. The typhoid death rate has, in nearly all cases, been greatly reduced, but in considering the effect of purer water supplies on the typhoid fever death rate, we must make due allowance for the decline in typhoid fever deaths from other causes now active.

It has been shown by Mr. George A. Johnson, Mem. Am.Soc.C.E., that we may reasonably attribute to water purification an average reduction of 16 deaths per 100,000 population in the thirty-three cities of over 100,000 population in 1910, that have introduced some form of artificial water purification. On this basis 2,600 typhoid-fever deaths are now avoided each year in these cities alone, and the saving in typhoid fever cases is estimated at 39,000 a year for these same cities. These conclusions are based on the typhoid statistics for the period 1900-1912, by comparing the average rate for 1900-1908 with the average rate for the period 1909-1912. Considering the increase in population supplied with filtered water since 1912, and the large number of cities and towns under 100,000 population having some form of water purification, it is evident that the above estimated saving of 2,600 typhoid fever deaths per year is probably much below the present total annual saving that has been brought about by the progress of water purification in the past ten years.

But the sanitary quality of our water supplies has also been generally improved by the close attention given to their quality in recent years, and the higher sanitary standards which an educated public has come to demand. More care is given to the protection and policing of watersheds, to the protection and cleaning of reservoirs, to the accidental contamination of lake supplies from shipping, and to the accidental contamination of surface supplies from railroad trains. Well protected ground water supplies have been sought for diligently as a superior source even to filtered surface waters, which depend, to some extent, on human vigilance for their purity, and the protection of ground waters and even deep well waters has been carefully studied. In all of these ways our general standard is higher and our water supplies distinctly better than they were even a decade ago.

A number of cities having supplies of naturally very hard waters, like Columbus, Ohio, have in recent years installed water softening plants as well as filtration, while at other plants iron removal, or removal of color, is accomplished as part of the purification process.

Water Filtration.—Stimulated by wide dissemination of modern ideas of sanitation, water filtration in the United States has made great progress during the past decade. The population supplied by filtered water, as shown by Table I., has increased from 3,160,000 in 1904, to 17,291,000 in 1914. As late as 1903 only about 60 cities and towns were supplied with filtered water, while there are now some 480 filter plants in this country with a total capacity of 2,585,000,000 gallons per day. These filters serve 40.68 per cent. of the urban population, while in 1904 only 9.66 per cent. of the urban population (Including all towns of over 2,500 population) was so supplied.

The relative growth of slow sand and rapid sand filtration during this period is interesting. It reflects strongly the relative adaptability to conditions in this country of the two types of filters and the gradual acceptance by the general public of ideas in water purification looked upon with prejudice less than ten years ago. Although slow sand filters were the first to be introduced, by 1904 rapid sand filters, including the earlier "mechanical" filters were far in the lead with a total population served of 2,600,000, as against only 560,000 supplied by slow sand filters. From 1904 to 1908, several very large slow sand filter plants were completed, at Philadelphia, Pa., Washington, D.C., and at Pittsburgh, Pa., and the relative lead of rapid sand filters was much reduced, although even then the population served by rapid sand filters was very nearly twice that supplied by slow sand filters. Since 1910, the growth of slow sand filters has been less marked. In 1914, a population of 5,398,000 received water from about thirty slow sand filters, while upwards of 450 rapid sand filters supplied a total population of 11,893,000.

Although there are now in this country fifteen rapid sand filter plants to one slow sand plant, the capacity of the larger slow sand filter plants is greater than that of any rapid sand filters yet built. The largest slow sand filter, located at Philadelphia, and in service since 1908, has a rated capacity of 240 million gallons per day. In contrast to this, the rapid sand filter at Cincinnati, completed in 1907, with a capacity of but 112,000,000 gallons per day, is the largest plant of this type in operation up to 1915. Present tendencies in this country are indicated by the fact that several cities are now building mechanical filter plants larger than any now in operation, while no large slow sand filter plants are under construction or projected. A rapid sand filter of 320 million gallons capacity, 30 per cent. larger than any existing slow sand plant, has been designed for the Croton water supply of New York. St. Louis is building a rapid sand filter of 160,000,000 gallons capacity, the city of Cleveland is building two rapid sand filters, with a combined capacity of 225 million gallons, the larger plant of the two having 150 million gallons capacity, and Baltimore is about to complete a rapid sand filter of 128 million gallons capacity.

The rapid sand filter has outstripped the slow sand filter principally because it is better adapted to handling waters of the high turbidity characteristic, at times, of practically all our rivers outside of the extreme northwesterly portion of the United States. In many parts of the country, the slow sand filter, unaided by auxiliary processes, more especially coagulation and preliminary sedimentation, would be incapable of continuously handling the water except at greatly reduced rates of filtration, owing to the rapid clogging of the beds and great difficulty and time required in cleaning. The rapid sand filter, using coagulation and ample preliminary sedimentation that relieves the filters proper of a very large share of the burden of purification, and with easy means of cleaning the filter beds, has, on the other hand, repeatedly demonstrated its ability to properly and economically filter the most turbid waters. The growing recognition by engineers of the merits of the rapid sand filter is evidenced by the final recommendation in a number of instances of rapid sand filters, reversing earlier recommendation of slow sand filters, as in the case of New York City, Baltimore and Minneapolis.

Although the limitations of slow sand filtration in handling waters of high turbidity were early realized, these filters were often favored in preference to rapid sand filters. Popular objection to rapid sand filtration arose on account of its use of a coagulant. This prejudice is well illustrated in the case of Washington, D.C., where popular agitation resulted in the building in 1905 of a slow sand filter after the original recommendation of a rapid sand filter. Prejudice against the use of alum, and, in fact, against the use of other chemicals, either for coagulating, softening, or sterilizing water has now been for the most part overcome. This is mainly due to the extensive use of coagulation at a large number of rapid sand filter plants, occasionally in conjunction with water softening, without ill effects on the consumer, and to the well-earned public favor enjoyed by the process of water sterilization by means of hypochlorite of calcium.

While the rapid sand filter has overcome the prejudice under which it labored ten or fifteen years ago, and has been demonstrated as equal, if not superior, in bacterial efficiency to the best slow sand filters, it is of interest to note that the attempt in recent years to apply slow sand filtration outside of its proper zone of relatively clear natural waters has not met with success. This attempt has brought about very radical departures from early slow sand filtration practice, and has obscured the original sharp distinction between this type and the rapid sand filter, without evolving a superior filter. It has been necessary to resort to coagulation at the Washington slow sand plant, in spite of very long preliminary sedimentation. At Philadelphia and at Albany, preliminary filters, which are practically rapid sand filters, have been added to better enable the slow sand filters to do the work originally expected of them. At Pittsburgh extensive modifications have been necessary to properly prepare the water for the slow sand filters that had been proved incapable, alone, of producing a satisfactory effluent. The reliance now placed on sterilization of the filtered water at most of the principal slow sand filter plants shows further the wide departure made from the original slow sand process, in the effort to keep the performance of some of these plants up to the standard originally intended of them without the help of these and other auxiliary processes. All of these processes are foreign to the original idea of a "natural" process for water purification, which gave to the slow sand filter much of its vogue and played an important part in meeting the early competition with the so-called "mechanical" filter and the present rapid sand filter.

The process of rapid sand filtration was highly standardized ten years ago, and has undergone little change since 1904 beyond the incorporation of water sterilization as an additional safeguard, and a more gen-

(Continued on page 112.)

THE MAPPING OF CANADIAN CITIES.

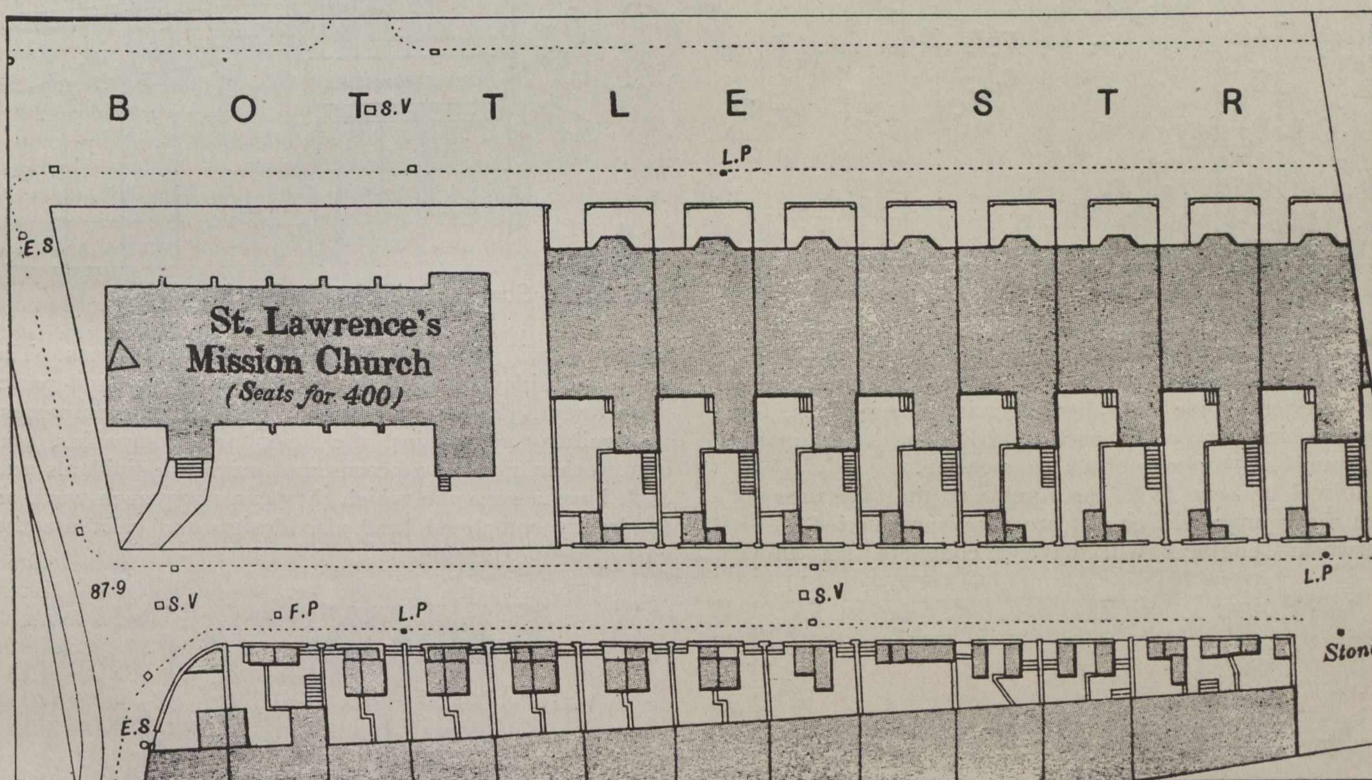
By Douglas H. Nelles, D.L.S., M. Can. Soc. C.E.

WE have in Canada a very important commission. It is called "The Commission of Conservation." It is not executive in character, but is an advisory body. It collects and tabulates accurate information upon the natural resources of Canada, including Fisheries, Game, and Fur-bearing Animals, Forests, Lands, Minerals, Public Health and Town-planning. If we analyze each of these branches we will find that when brought down to their basic principles they all deal with "The Conservation of Human Life."

The most important branch of the commission's work is, therefore, the Town-planning branch, dealing, as it does, with human life in its most concentrated form. The health, intelligence and morality of the community depend upon the health, intelligence and morality of the individual, and this is to a great extent the result of the environment in which the individual lives and grows to manhood. Town-planning has, then, for its basic object the betterment of the individual through improving the environment in which he lives. That is to say, laws are passed which enable those who preside over the future destinies of the city to so control and regulate the growth of the city that the residential portions shall be in the localities most suited for healthy homes, that the homes themselves shall be built properly and not crowded, that the business section shall be in the most suitable situation, and that the manufactories shall be kept in the locality best suited to them.

In planning the localities for the different kinds of activities of city life various detail problems enter into the problem as a whole, such as transportation, involving location of railway tracks, yards and terminals, in regard to both passenger and freight service; rapid transit and street car service; the direction and width of roads; reclaiming of low and swamp lands and turning them into healthy parks and lakes; the location of sewers and water service, and many other problems which will be mentioned later on.

In order that the planning may be done in the most intelligent, systematic and economical manner it is absolutely necessary that there should be a large-scale topographical map of the city and the surrounding district which come under the town-planning scheme. There should also be a smaller scale map, published upon a scale of about six inches to a mile. The six-inch map is for planning the scheme in its general outlines, and the large-scale map is for working out the detailed problems of the scheme and the engineering problems encountered when the plan is put into action. Besides town-planning, these maps will form the basis of all the work and records of the city's engineering department, and also other city departments.

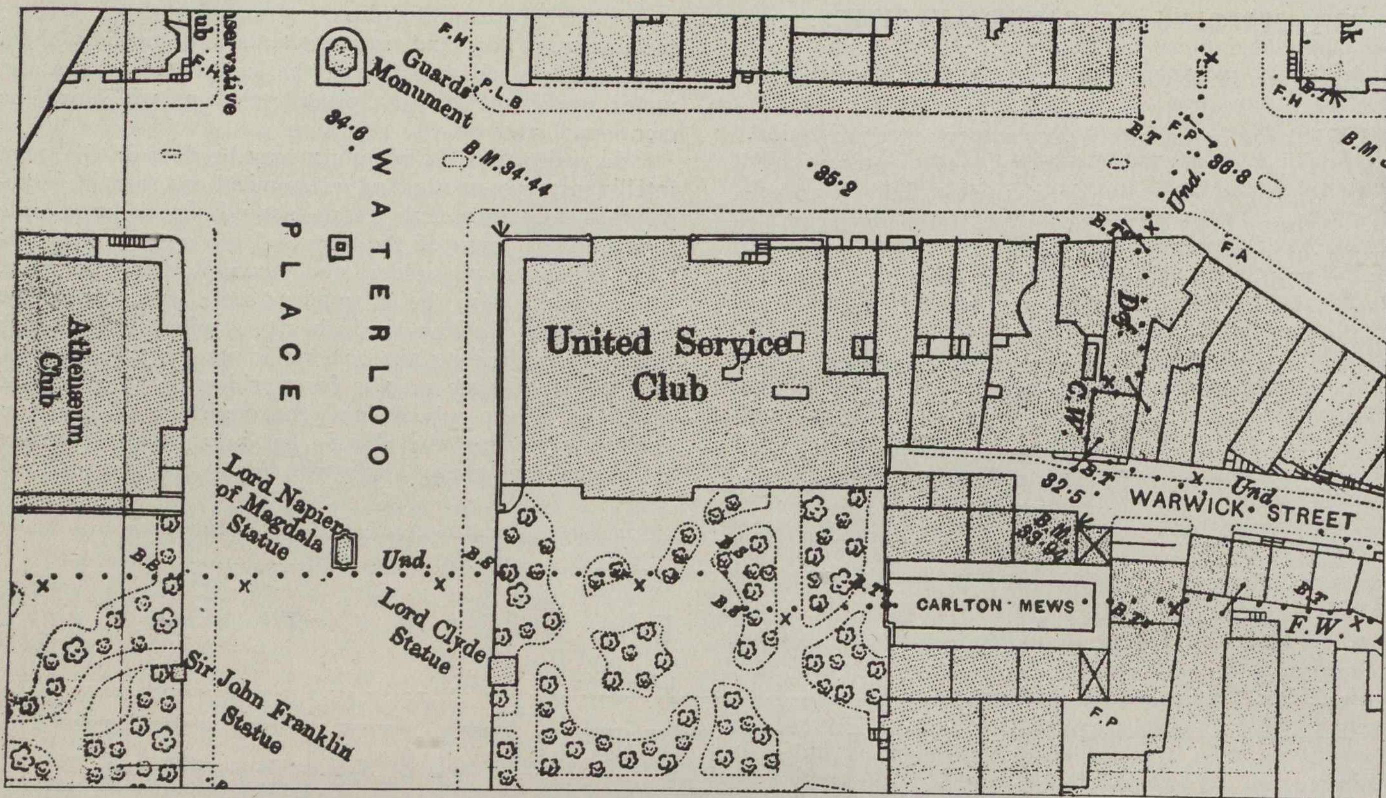


Specimen of the City of London, England, Map, 1/500 Scale. Published in Black.

The mapping of cities and towns in Canada on a large scale has not yet been attempted, but it is most important that such maps should be prepared as will be shown during the course of this article. This is especially so "because of the extent to which land has been subdivided beyond the limits of built-upon areas of most of our Canadian cities."

SCALE OF MAP.

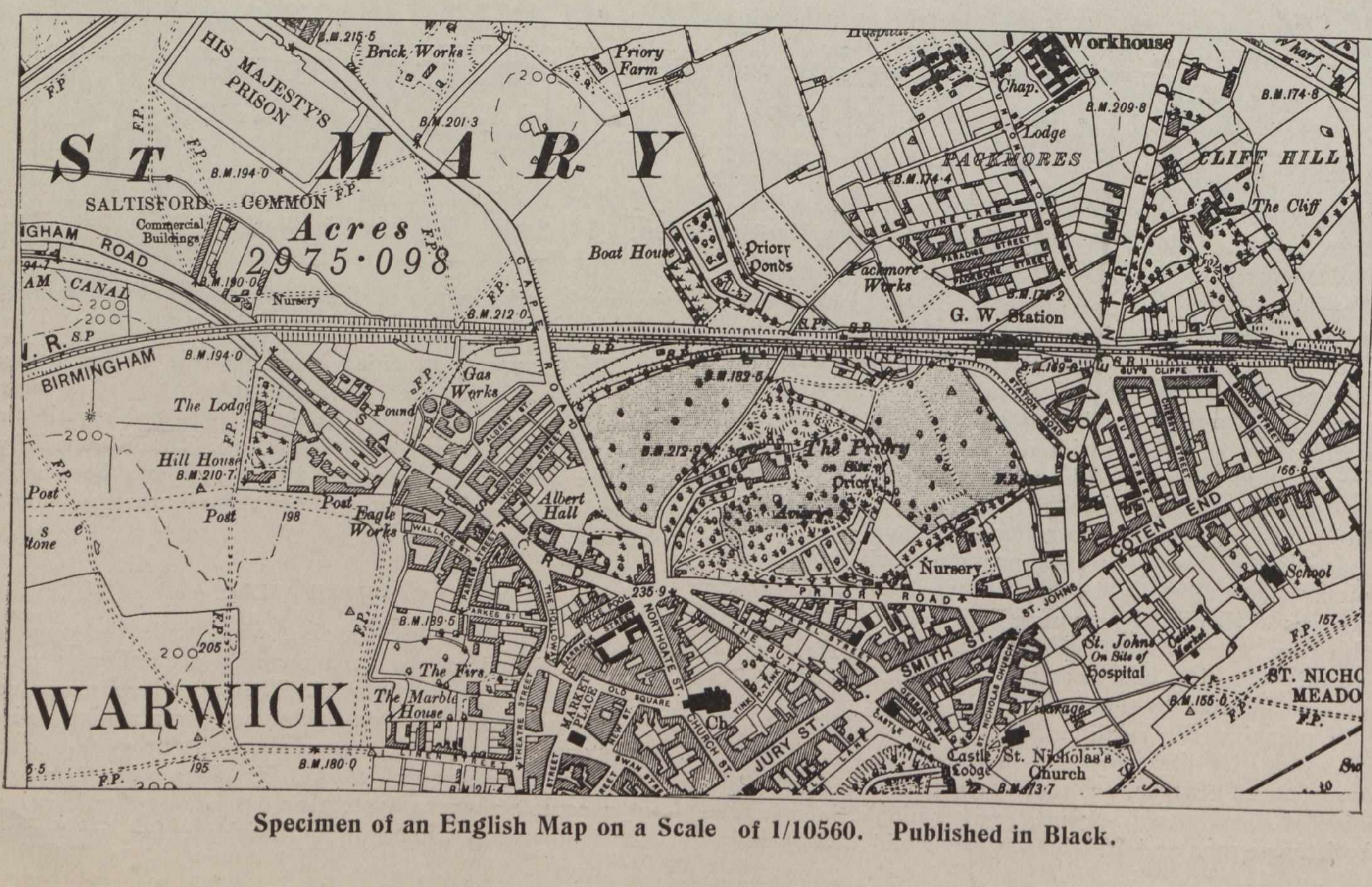
Uses of Map.—In deciding what scale the map is to be published on we must examine the different purposes for which it will be used. They may be enumerated in part as follows: For city planning, for planning relief and storm sewers, or a complete sanitary system and the location of disposal works, for planning and laying out a complete water system or extensions, for locating new roadways, laying out subdivisions, for improving



Specimen Map of the City of London, England, 1/1056 Scale. Published in Black.

creeks, for landscape and parks works, for bridge works, for railways, their terminals and yards, for tunnels and canals, for gas pipe lines, for electric wiring lines, for telephone lines, even for architectural work, and many other purposes too numerous to mention.

It will be seen from the foregoing that the uses to which a city map will be put are many and varied. The waterworks engineer will have a complete set upon which he will show all his water and sewer lines. The road and sidewalk department, the driveway and parks department, the gas companies, the electric companies, the railway companies, the telephone companies, and many other smaller concerns and private individuals will each have a set upon which they can show such work as is already completed, and also design and calculate the cost of new extensions.



Specimen of an English Map on a Scale of 1/10560. Published in Black.

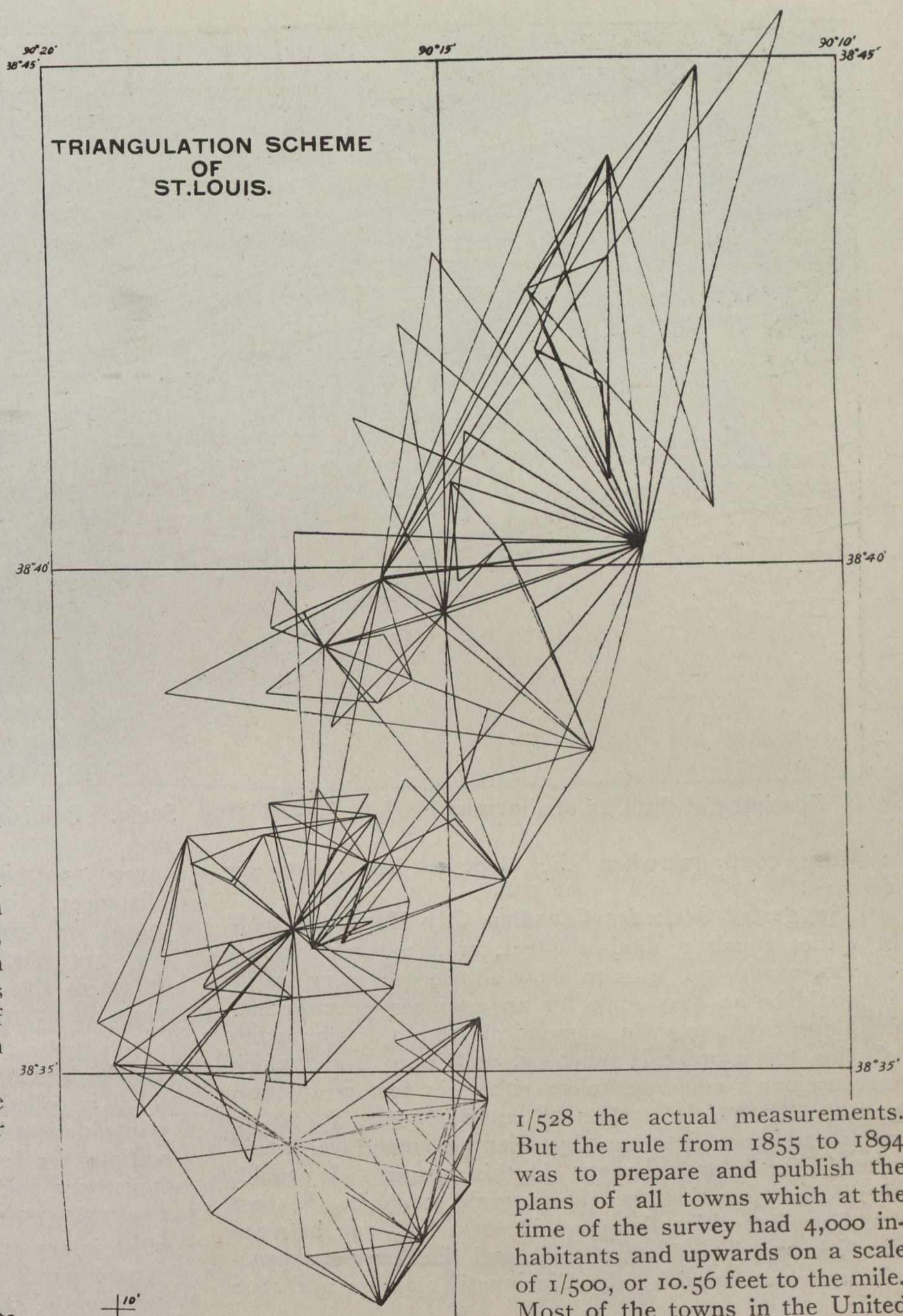
Data Shown on Map.—Having examined the uses to which the map will be put, we find that it will be necessary in order that it will be of the greatest value to all for it to show the following data: Buildings, sidewalk and road lines, trails and foot-paths, fences, boundary lines, railroads, canals, streams, rivers, lakes, tunnels, bridges, dams, locks, wharves, docks, jetties, breakwaters, ferries, fords, falls and rapids, marsh, hydrants, manholes, drainage grates, trees, triangulation stations, primary traverse stations, bench-marks, located land monuments, and the elevation and form of the ground surface by means of contours. It should also show the difference between public buildings, business buildings and residences.

And finally, before deciding upon the scale of the map, let us see what other countries have done in this respect.

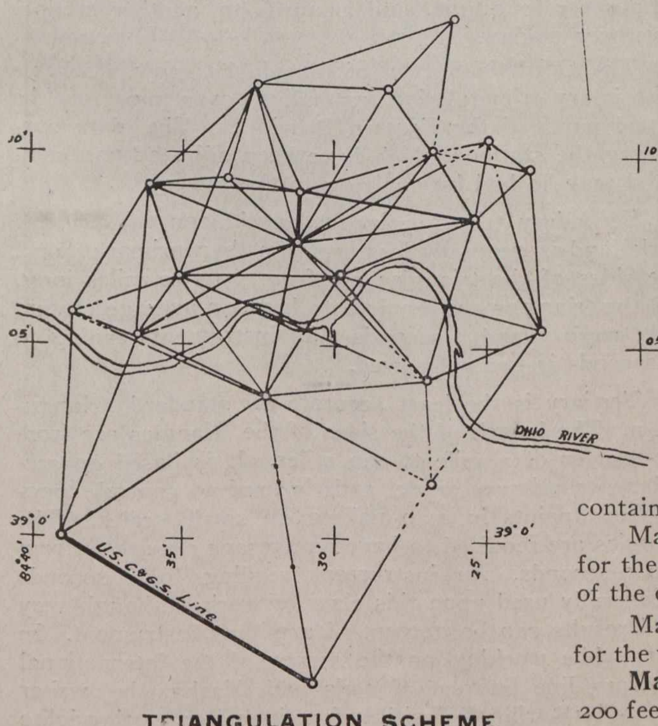
Memorandum on Large-Scale Maps of Great Britain.—"Town maps of the whole of the United Kingdom have been prepared on various scales. In England and Wales 408 towns, and in Ireland 105 towns, have had plans prepared and published in the ordinary course of the survey on large scales; and, in addition to these, large-scale plans of 33 smaller places in Ireland have been prepared but not published.

"The first scale adopted was 5 feet to a mile, or 1/1056 the actual measurement on the ground; the plans of London, Dublin, Belfast, and some smaller towns are still on this scale, and the original plans of the towns in Yorkshire, Lancashire and the South of Scotland were prepared and engraved upon this scale.

"There are also a few places that have plans on the scale of 10 feet to a mile, or 1/528 the actual measurements. But the rule from 1855 to 1894 was to prepare and publish the plans of all towns which at the time of the survey had 4,000 inhabitants and upwards on a scale of 1/500, or 10.56 feet to the mile. Most of the towns in the United Kingdom, therefore (London, Dublin and Belfast being, as above said, exceptions), have plans on this scale, which is large enough to show doorsteps, the thickness of walls, and the divisions of buildings. Most of the town plans also show all objects connected with water supply, lighting and drainage, such as hydrants, sewers, manholes and gratings. Levels are shown along the streets and bench-marks are cut at frequent intervals, showing to two places of decimals the altitudes above mean sea level. Areas are not shown on the town plans."



TRIANGULATION SCHEME OF ST.LOUIS.



TRIANGULATION SCHEME OF CINCINNATI

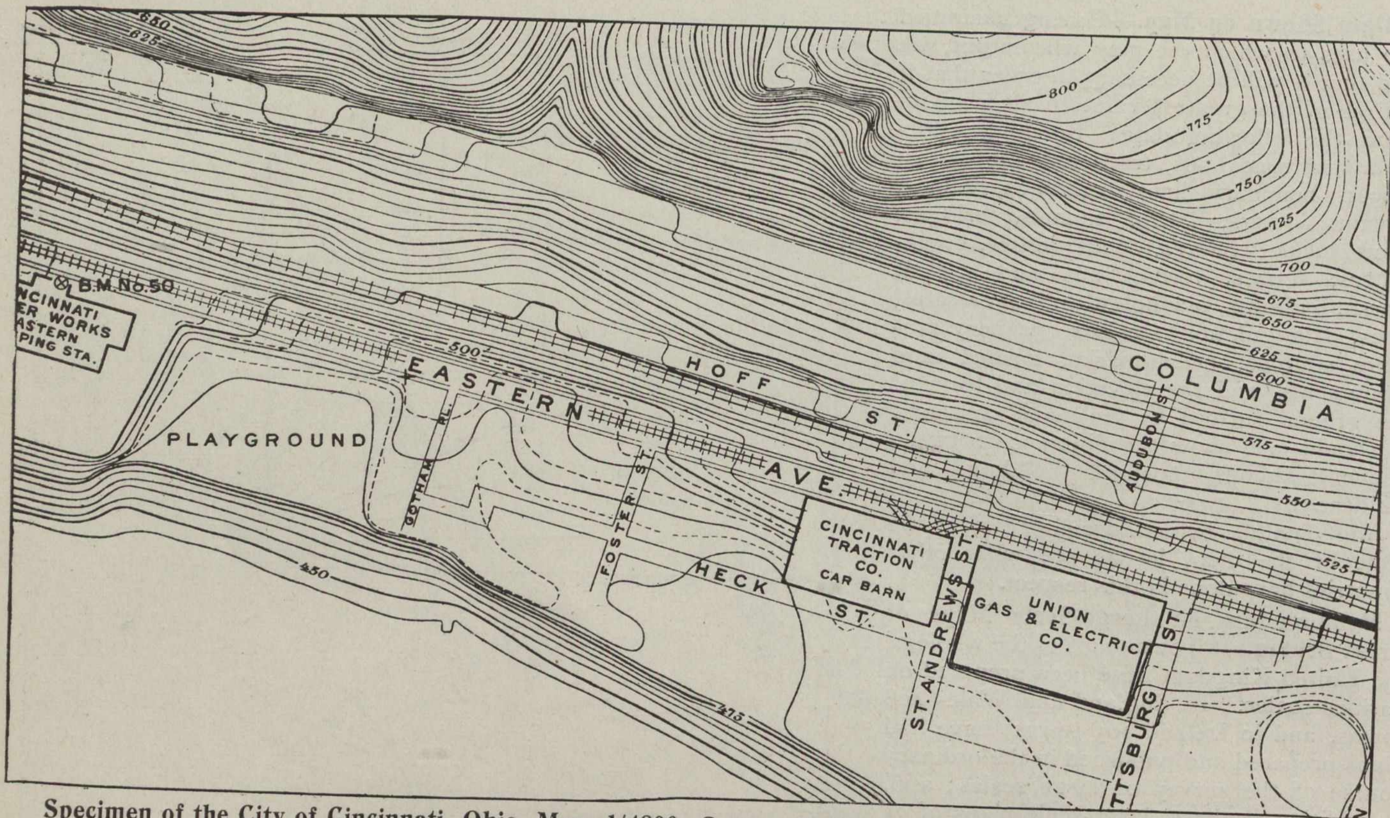
The plans on the scale of 1/500 are similar in size to the 1/2500, or 25-inch plans, namely, about 36 x 25 inches, and contain an area 24 x 16 chains, or 38.4 acres.

Maps on a scale of 1/2500, or 25.34 inches to the mile, are published for the whole of the cultivated districts of Great Britain, and the survey of the cultivated portions of Ireland is in progress.

Maps on a scale of 1/10560, or six inches to the mile, can be obtained for the whole of the United Kingdom.

Map of St. Louis, U.S.A.—This map is on a scale of 1 inch equals 200 feet, or a natural scale of 1/2400, with a contour interval of 3 feet.

Map of Cincinnati, U.S.A.—This map is on a scale of 1 inch equals 400 feet, or a natural scale of 1/4800, with contour intervals of 5 feet and



Specimen of the City of Cincinnati, Ohio, Map, 1/4800 Scale. Published in Black, Blue, Brown and Green.

2½-foot contours when the slope is less than six degrees.

Suggested Scale for Canadian City Maps.—A scale of 1 foot equals a thousand feet, or a natural scale of 1/1000, would enable us to show all the necessary detail. It would be an easy scale for an engineer to make calculations from, a scale economical from the standpoint of the topographical surveyor, and one from which measurements could be taken either in feet or meters; and, as the metric system of measurement is coming more and more into use by scientific men, we should provide for future changes in this respect. It would, therefore, seem that the 1/1000 scale would be the best for Canadian cities, lying as it does half-way between English practice of 1/500 scale and the American practice as represented by the Cincinnati map on a 1/4800 scale.

METHODS OF SURVEY.

Triangulation. — In all surveys for map-making, where there is any considerable area to cover it is necessary to have a scheme of triangulation, making a network over the territory to be mapped. Triangulation is generally divided into three classes, Primary, Secondary and Tertiary.

Primary triangulation is the most accurate known method of measuring long distances, and is used for co-ordinating detached surveys and for computing the figure and shape of the earth. It consists of a scheme of triangles whose sides are from 10 to 100 miles in length. The angles are read with an instrument whose microscopes read to the tenth part of a second. The three angles of each triangle must add up to within one second of 180 degrees, plus the spherical excess, and the side equations must be so that the average absolute error must be less than 0.4 of a second before the field-work is accepted by the geodesist's office. Base lines of from six to ten miles long are measured approximately every 150 miles apart to check up the accuracy of the distances. In measuring a base line an invar tape is used, and great care is taken throughout the operation to insure such accuracy that the probable error in the mean of the several measurements shall not be more than about one part in 2,000,000.

Laplace points are also put in about 150 miles apart. In the adjustment of the triangulation they take out what is called the "twist" of the scheme. They consist of geodetic triangulation stations at which precise observations for longitude, and azimuth to another station, have been made.

The Geodetic Survey of Canada has now a scheme of primary triangulation extending over most of the settled parts of the Eastern Provinces. The data concerning the stations which have been adjusted and computed may be had by applying to the Survey.

Secondary triangulation is based upon the primary work, and is generally less accurate than primary work. The sides of the triangles are from 2 to 10 miles long, and the triangles are required to have an average closure of between 2 and 3 seconds. An instrument reading to 10 seconds is generally used.

Tertiary is the least accurate of standard triangulation. The length of the sides of the triangles are from one-quarter of a mile to ten miles. It is based on secondary or primary work, and is used to control topographical points in map-making on small scales. The triangles are required to have an average closure of from 4 to 5 seconds. An instrument reading to 10 seconds is generally used upon this class of work, although very good results can be got out of a minute instrument. In 1911, while working on the survey of the international boundary line between Canada and Alaska, the writer observed 18 triangles with a four-inch Berger theodolite reading to single minutes, and had an average closing error of 4 seconds per triangle.

In city surveying, it is the general practice to do the triangulation with a primary instrument and with primary methods. A main scheme of quadrilaterals is laid out over the district, and from the main stations a large number of intersections are observed, so that altogether there are located about two stations per square mile. These triangulation stations now form the main control points. The error in distance between any two of them should be less than one inch. All other lineal measurements in connection with the making of the map are tied on to them and the closing error of the line distributed along the line between starting and closing stations.

The adjusting of the triangulation should only be done by a competent adjusting staff, such as is engaged in that work under the direction of Maxwell Tobey, geodesist, and assistant superintendent of the Geodetic Survey of Canada. The methods used are those known as the "Method of Conditions" and the "Method of Co-ordinates."

The city triangulation schemes would be based upon the Primary Triangulation of Canada.

Traverses.—Parallel main traverse lines should be run about half a mile apart in the centre of the city where it is thickly built up, and about a mile apart in the outlying districts where it is thinly settled. They should be tied in to triangulation stations about every half-mile. In computing the traverse, the bearings of the courses are first adjusted so as to give as nearly as possible the true astronomical azimuth at each station. The latitude and departures are then computed and adjusted between the triangulation stations.

After the main lines have been surveyed, secondary lines are run down parallel streets, starting from, and ending on, a station of the main lines. They should be run just as accurately, adjusted and computed in the same manner as the main lines, but are not necessarily connected directly with triangulation stations.

Too much cannot be said about the importance of leaving permanent survey marks. It very often happens that an expensive survey is made and no permanent marks left upon the ground. The only results of such a survey would be its plan or map. In many cases when certain information is wanted and it becomes necessary to make another survey, a large amount of resurveying is done that would not have had to be done if permanent marks had been left on the original survey. It is, therefore, advisable that permanent marks, consisting of a small bronze bolt, ¾ in. in diameter and 3 in. long, be put in the concrete sidewalk at every street corner to mark the traverse stations.

The traverse routes should be so chosen as to give the shortest length of traverse line. What is meant by this is explained by Fig. 1. In most cities the blocks are oblong, as in the sketch. In this case the main traverse lines should be east and west and the secondary north and south.

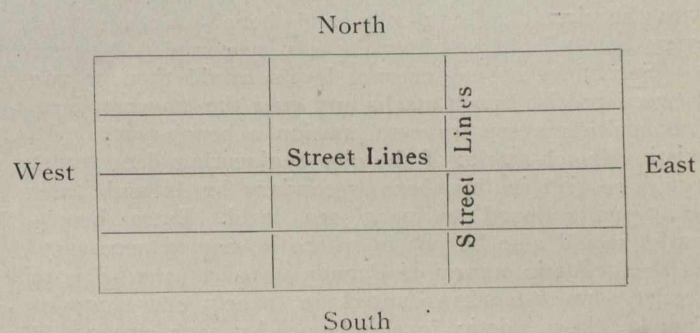
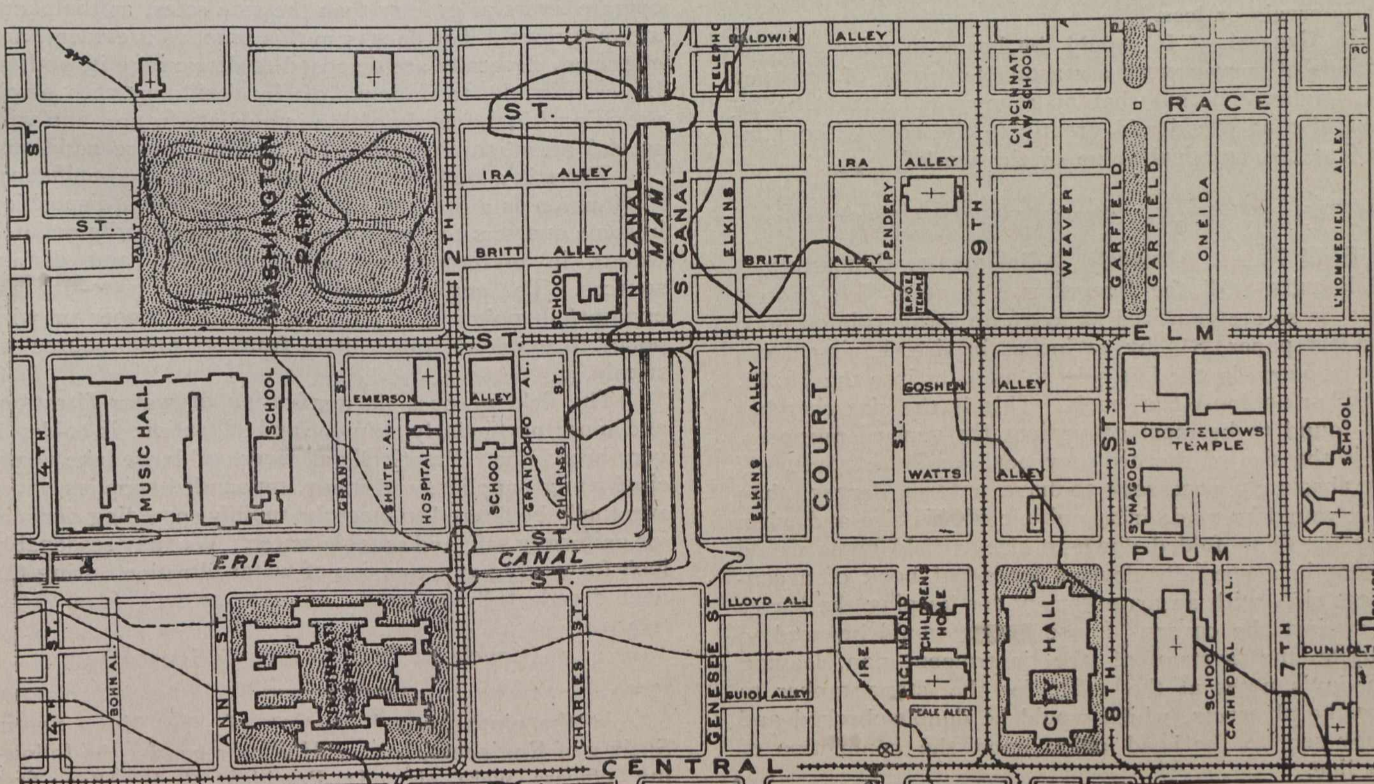


Fig. 1.

The angles should be read with a 10-second vernier transit by a single, direct and reversed reading, and reading both verniers in such a way as to give the bearing of the forward course. When the reversed readings are finished the instrument is left clamped,



Specimen of the City of Cincinnati, Ohio, Map, 1/4800 Scale. Published in Black, Blue, Brown and Green.

and when taken forward to the next station and the telescope pointed to the back picket in the direct position, the verniers will read the correct bearing of the course.

The chaining should be done with a 100-foot steel tape. When chaining on slopes the angle of slope should be measured and a correction applied. A thermometer should be attached to the end of the chain and a reading taken at the end of each course.

Precise Levelling.—It is the general practice in city surveying to cover the city with a scheme of geodetic or precise levels. In planning this scheme reference should be had not only to the needs of the topographic survey, but also to the future needs of the city's engineering department. In the Cincinnati survey the precise bench-marks averaged 2.2 per square mile. In St. Louis they averaged 12. per square mile. For Canadian cities, if a circuit were run around the outside of the district, parallel lines one mile apart run across it, and connected with the circuit at both ends, and bench-marks set at every half-mile, it would make a very complete system.

Secondary or engineering levels would then be run between precise bench-marks and over the traverse lines, thus making every traverse station a bench-mark. All existing bench-marks of the city engineering department would be tied in by these secondary levels and their elevations reduced to mean sea level. Extra bench-marks would also be put in where it seemed necessary. As the geodetic survey of Canada now has one or more geodetic bench-marks situated in nearly every city of Canada, the geodetic level scheme for each city would be based upon them.

Topography.—In the business section of the city the topography would be taken by a chained survey, similar to the English system of tieing in buildings. For the residential district, parks, open ground and outlying districts the plane-table would be used. Street lines, road fences, and sidewalks would be tied in when the traverse was chained. Contours would be shown at five-foot intervals or less.

In General.—"It should be borne in mind that in all kinds of survey work a reasonable degree of accuracy is a desideratum, but that no refinements should be introduced that would add greatly to the cost without increasing the practical value of the work."

METHOD OF KEEPING SURVEY RECORDS.

Field Notes, Abstracts, Adjustments, Computations and Results.—All the foregoing, excepting field notes, would be so systematized as to go on forms printed upon loose-leaf paper, 8½ by 11 inches in size, having seven holes punched in the left side so as to fit into the Mc.M. Multiple-ring loose-leaf book. This is the size that has been found to be most convenient for general purposes, and is the size of the ordinary business letter sheet. If it is absolutely necessary to have a form larger than this it would be made in a multiple of this size and when ready for filing folded down to size. Field notes would be kept in a specially devised loose-leaf book of a convenient size, with an arrangement for keeping the leaves flat against the covers. Loose leaves would be used to facilitate the system of the instrument-man, leaving each day's notes at the office for the stenographer to make the abstracts, which would be double-checked and a copy sent to the head office upon the completion of each line.

In connection with the loose-leaf system there would be a card index, through which, by a system of cross-reference, each particular kind of information could be approached from a number of different directions.

Keeping Track of Costs.—The chief of each field party would be required to turn in a weekly report, stating the details of each day's work. Each member of the office staff would be required to turn in a similar statement. From these statements the efficiency of each member of the staff would be determined and the detailed cost of each part of the work. From these records, after one city had been surveyed, it would be easy to make a very accurate estimate of the cost of making a map of any other city.

(Concluded in next week's issue.)

FOURTH DIVISIONAL CYCLIST CORPS.

No. 2 Detachment Corps of Guides, with headquarters at the Toronto armories, commenced this week to recruit for a Fourth Divisional Cyclist Corps, for active overseas service.

As the work of this corps will consist largely of mapping, reconnaissance, and preparing reports, men with engineering training are especially wanted.

Definite information may be obtained by writing Lieut. C. S. McKee, O.C. of the Detachment, or by interviewing any of the officers or N.C.O.'s at the orderly rooms in the armories, Tuesday or Thursday nights.

RECENT PROGRESS IN WATER SUPPLY.

(Continued from page 106.)

eral appreciation of the importance of preliminary sedimentation. Filters of this type follow closely the lines of the original modern rapid sand filter built in 1902 at Little Falls, N.J.

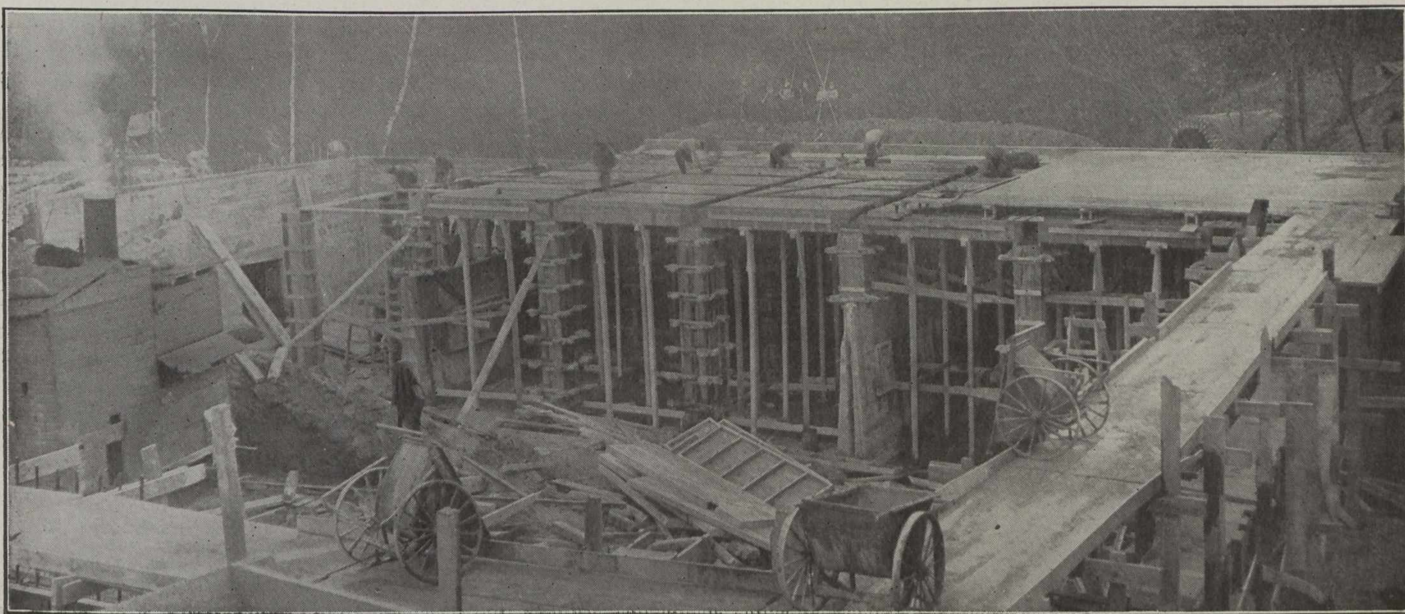
Although it is well understood that any filter has a definite limit of capacity beyond which it is not possible to obtain properly purified water, there is a tendency to operate filters at greater than the safe rates, as the plants are outgrown. The danger in this practice is evident, and engineers generally are disposed to discourage it, and, so far as possible, to anticipate it by designing with ample provision for the needs of the immediate future, and with special attention to facility for making future additions.

There is a further tendency of late to over-confidence in filtration as a preventative of disease, and a disposition in some quarters to attempt the filtration of badly polluted waters in preference to more expensive and distant sources. The engineer and the sanitarian of to-day are engaged in pointing out that it is not a proper or wise policy to overload water filters from a poor source of supply.

The field of possible application of water filtration, and more particularly rapid sand filtration, is to-day a very broad one. Practically all river and large lake municipal water supplies, and many impounded supplies, must eventually be filtered to meet the rapidly spreading demand for uniformly safe and potable water. We may reasonably look forward to an extension of water filtration during the next decade fully as great as the growth from 1904 to 1914.

(Concluded in next week's issue.)

At the ninth annual meeting of the Nova Scotia Society of Engineers, held at Halifax recently, the following officers were elected: President, J. L. Allan; first vice-president, W. S. Ayars; second vice-president, A. J. Barnes; secretary-treasurer, D. McD. Campbell.



General View of Tank Before Erection of Weir Walls; Roof Partly Constructed.

TANKS FOR TEMPORARY STORAGE OF STORM WATER

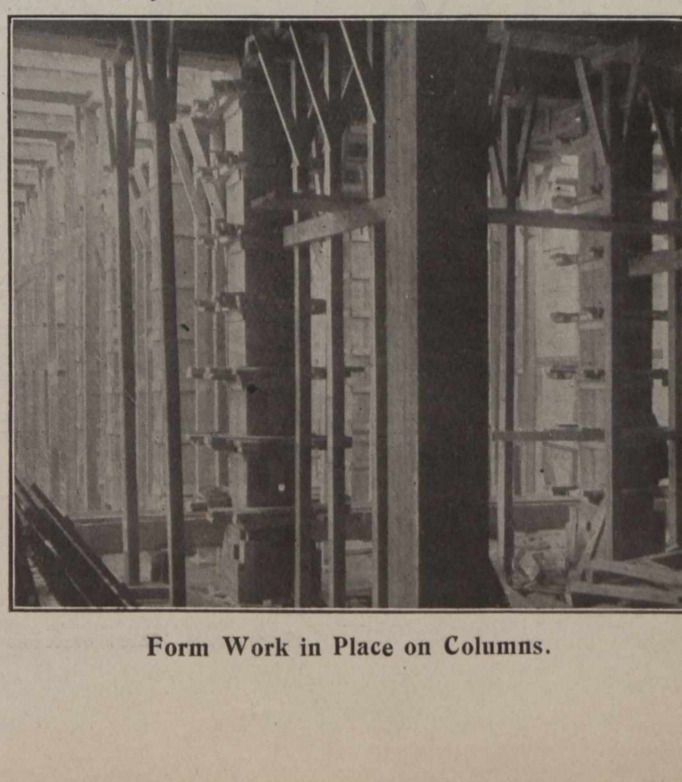
DESIGN AND METHODS OF CONSTRUCTION OF STAND-BY TANKS IN HIGH PARK, TORONTO—AFTER DETRITUS HAS SETTLED, ONLY VERY DILUTE WATER PASSES INTO LAKE ONTARIO.

By W. G. Cameron,
District Engineer, Sewer Section, Department of Works, Toronto.

THE West Toronto stand-by tanks are situated at the southwest corner of Keele and Bloor Streets in High Park. The site, which is the lowest ground in this neighborhood, is the bed of a small creek which crosses Keele Street immediately south of Bloor. The creek is nearly dry except for storm and spring flood water. Keele Street is filled in across this creek and is about 15 feet above the level of the present top of the tanks. A culvert is provided where the fill was made, and now discharges into the storm water outlet. The site was covered with small trees and scrub and in places was wet and boggy.

Purpose.—The object of the tanks is to provide a temporary storage for flood and storm water. If the volume of water is not too great for the capacity of the tanks, it is discharged gradually into the 18-inch sewer under the large storm water outlet, and carried eventually to the disposal works at Morley Avenue. In this way, the 18-inch sewer is not overtaxed. If, on the other hand, the volume of water is too great for the capacity of the tanks, the water is discharged over weirs into the large storm water outlet. But the tanks provide a temporary resting place where the detritus, etc., may settle, and, when the storm has subsided, may be drawn off in the 18-inch sewer, while only the very dilute water from the surface passes directly to the lake without being treated.

Inlets.—The inlet sewers were all built before the tanks were constructed, so the tanks formed the missing link in the system. There were three of these inlets, one from the west ("A" on Plan, page 115), one from the east (B) along Bloor Street, and one from the north (C) along Keele Street. C is a 7′ 6″ x 8′ 0″ concrete culvert, into which flows a 9′ 3″ circular sewer. The sewer from the west enters the tanks at the north end of the west side as a 6′ 9″ x 5′ culvert. The sewerage flows into a channel across the north end of the tanks, contained on the one side by the north wall of the tanks, and on the other by a weir. By means of this weir, the dry flow is guided into a small 2′ x 2′ 2″ culvert, which discharges into an existing 3-ft. sewer down Keele Street. The storm water passes over the weir into the tanks. If, at some future time, the 3-ft. sewer down Keele Street be overcharged, a 12-in. pipe sewer is provided, and, by opening a valve



Form Work in Place on Columns.

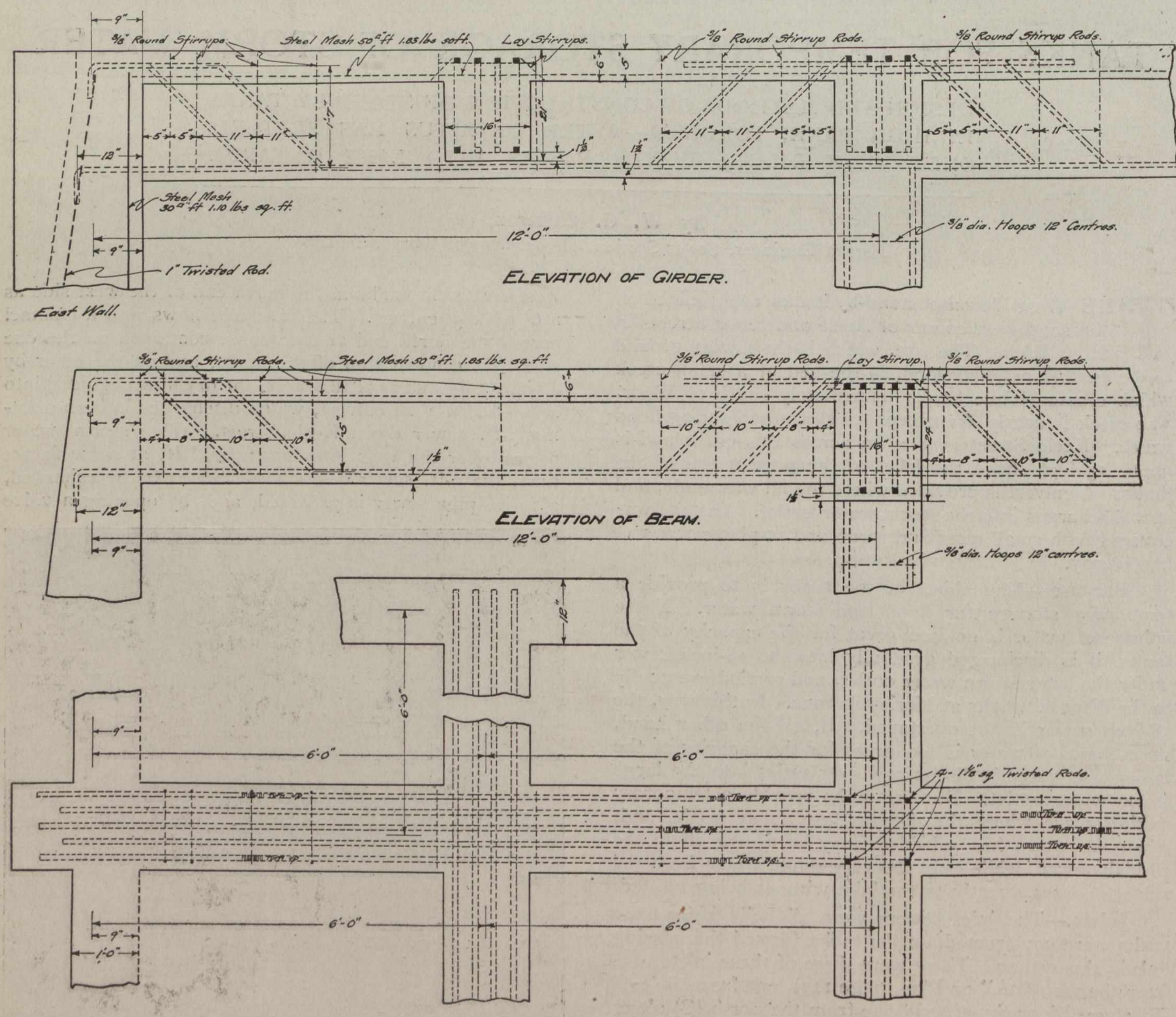
at the weir, the surplus can be drawn off through it into the 18-in. pipe under the storm water outlet.

The sewer from the east (B), 2′ 6″ x 3′ 9″, egg-shaped, enters the east side north of the centre. This sewer does not really empty into the tanks proper, but into the upper part of the storm water outlet. Even here, it is only overflow storm water that is discharged. The dry flow discharges into the 3-ft. sewer down Keele Street over which this Bloor east sewer passes.

The sewer from the north (C) enters the tanks at the east end of the north side. One hundred and seventy-three feet north of the tanks a weir is provided in this sewer, by which the dry flow is diverted into a 24-in. tile pipe sewer (D) leading directly into the end of the 3-ft. sewer down Keele Street. This 24-in. pipe also has an overflow provided, in case at any time the 3-ft. sewer should be overcharged and back up into the 24-in. pipe. This overflow leads indirectly into the 18-in. sewer under the large outlet. The storm water from the north flows over the weir in C, 173 ft. north of the tanks, and into the tanks. Thus we see that the dry flow from all these inlets does not reach the tanks, but all discharges into the 3-ft. sewer down Keele Street on its way to the disposal works, while only the storm water finds its way into the tanks.

Design.—The tanks are rectangular in shape, and approximately 104′ x 112′. On the north side, there is a channel 3.5 ft. deep for the Bloor West sewer, separated from the tanks by a weir. This has been described above. On the east side, there is a section 4 ft. deep, separated from the tanks by a weir, and from the storm water outlet by another weir. Into the north end of this section the storm water from the Keele Street sewer flows. The bottom of this section is graded back towards the north end and a gate valve is provided which can be opened to allow the section to drain into the storm water outlet. The tanks proper are divided into three parts, 17½ ft. deep, by two weirs. These three divisions are graded towards the east side, where they drain into an open 18-in. sludge channel, which runs south along the inner side of the east wall and into the 18-in. tile sewer under the storm water outlet. A gate valve is provided at the end of the sludge channel at the south wall.

Eight rows of columns were used in the tanks for the support of the roof. These columns were 18 ins. square



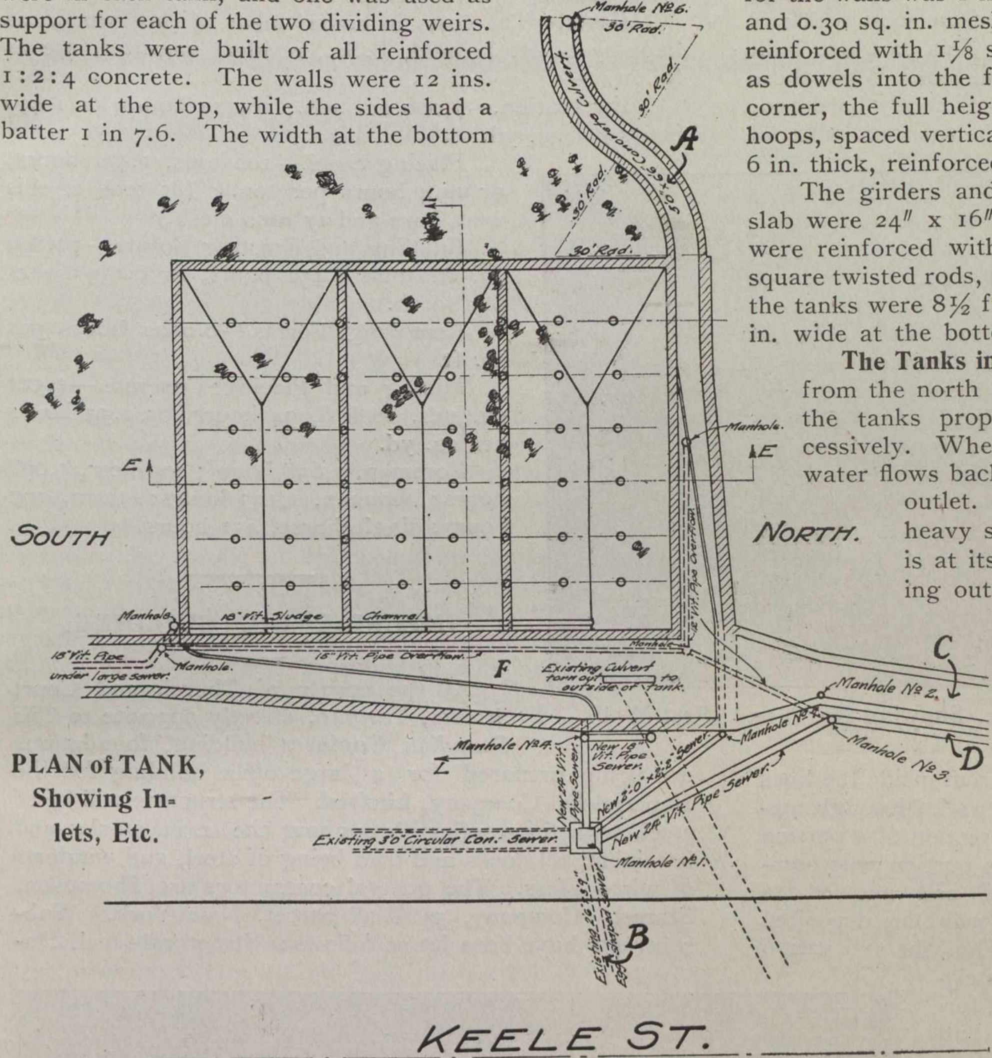
SECTIONAL PLAN THROUGH BEAM AND GIRDER.

in section, 12 ft. apart centre to centre in the rows and 12-ft. centres between the rows. Two rows of columns were in each tank, and one was used as support for each of the two dividing weirs. The tanks were built of all reinforced 1:2:4 concrete. The walls were 12 ins. wide at the top, while the sides had a batter 1 in 7.6. The width at the bottom varied as the height. There was a footing provided 2 ft. deep and 12 ft. 6 in. wide. The reinforcing for the walls was 1-in. square twisted rods on the outside and 0.30 sq. in. mesh on the inside. The columns were reinforced with 1⅛ sq. in. twisted rods, 2 ft. 6 in. long, as dowels into the footing, one 1⅛ sq. in. rod in each corner, the full height of the column, and ⅜ in. round hoops, spaced vertically 12 in. apart. The roof slab was 6 in. thick, reinforced with 0.5 sq. in. mesh.

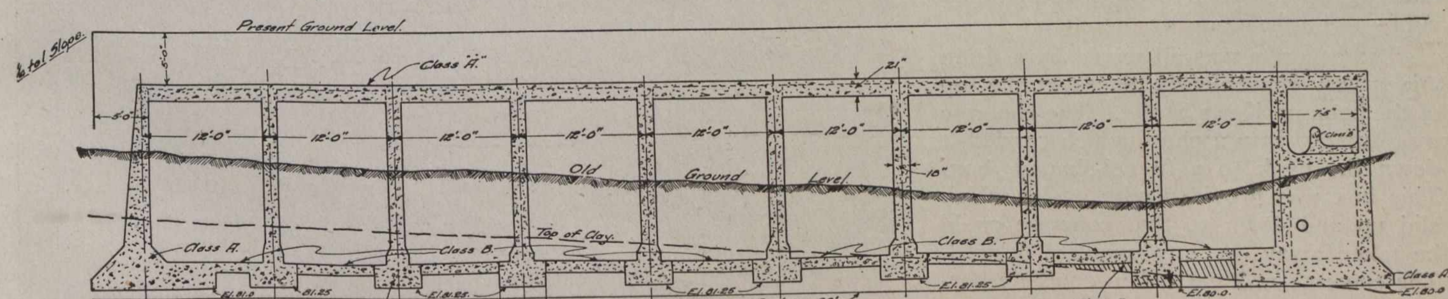
The girders and beams for the support of the roof slab were 24″ x 16″ and 21″ x 16″ respectively. They were reinforced with 1 sq. in. twisted rods and ¾ in. square twisted rods, respectively. The weir walls between the tanks were 8½ ft. high, 9 in. wide at the top, and 18 in. wide at the bottom, reinforced with ¾ sq. in. bars.

The Tanks in Action.—During a storm, the water from the north and west passes over weirs and into the tanks proper, filling the three divisions successively. When all three and section F are full, the water flows back over the weir into the storm water outlet. But this will happen only during a heavy storm, and then only when the storm is at its height. Therefore, the water passing out through the storm water outlet will be practically pure storm water.

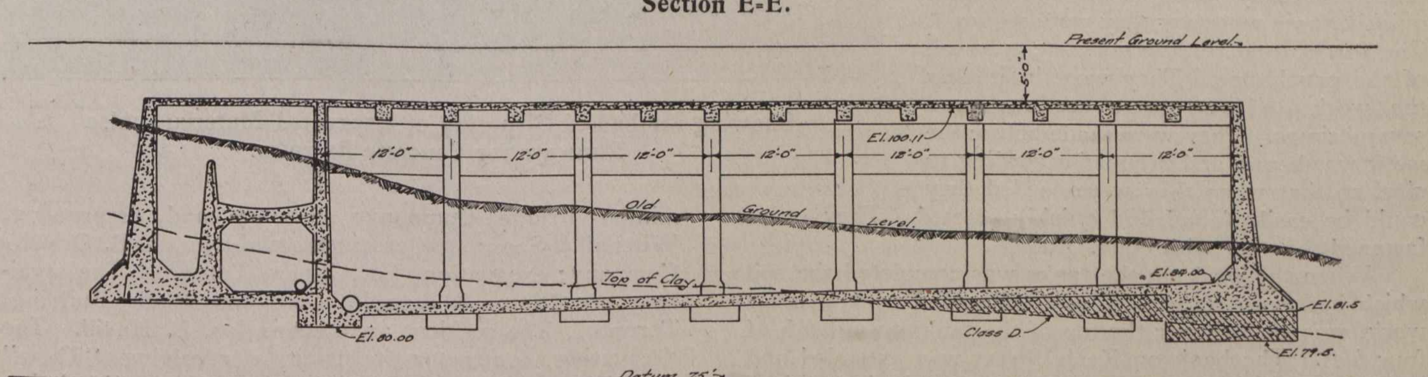
In each of the three tanks there is a floating arm situated at the east wall, which floats on the surface of the water and collects any floating material and carries it into the 18-in. pipe under the storm water outlet. When the storm has subsided the tanks are drained, gradually, through the sludge channel into the 18-in. pipe. There is a water connection provided at the west end of each tank so that the tank may be flushed clean after it has been in use.



PLAN of TANK, Showing Inlets, Etc.

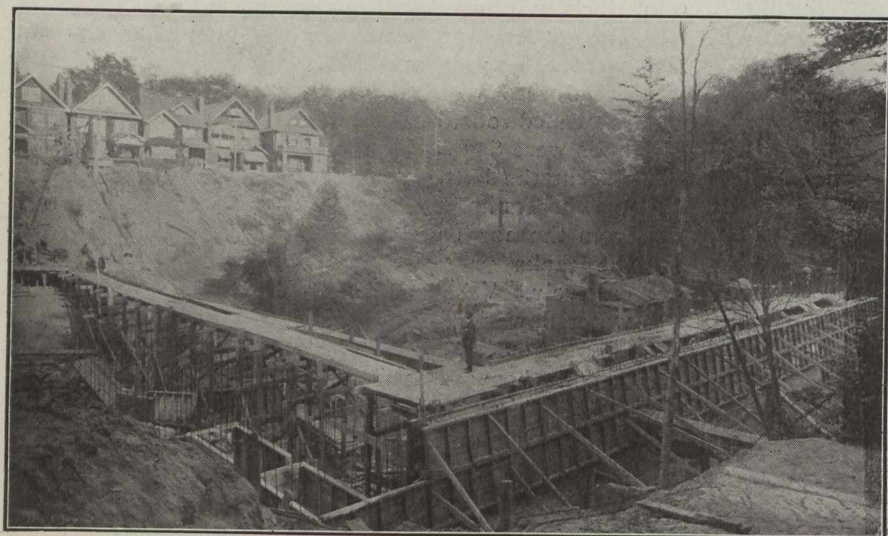


Section E-E.



Section L-L.

Construction.—The ground on which the tanks were built was composed of sand on the surface, which, in small areas, formed pockets. The sub-soil was hard, blue clay. Trenches were excavated by hand for the west wall and the western third of the north wall. This part was built first because the ground was low at this side. When these walls were built, and the concrete sufficiently hardened, they were used as a retaining wall for the next material excavated. This material was taken from inside the lines of the future tanks and next the west wall. Enough material was taken out to allow for the erection of a portion of the tanks on the west side. This portion was completed floor, columns, weirs and roof and allowed to harden. The next material excavated was then deposited on the roof of this finished portion. Thus the excavation and construction proceeded alternately from the west. A clam shell was used for excavating in the body of the tanks, but the clay was so hard that the most of it had to be loosened with picks before it could be gathered up by the clam.



View of Ground and Start of Work, Showing North and West Walls.

The concrete was all mixed by a drum mixer very conveniently placed at the top of the bank on Keele Street. The concrete was dumped into a chute which carried it down the bank to a funnel-shaped box. This box was provided with a slat which slid up and down so that concrete could be taken away in any quantity desired. The concrete was carried in concrete barrows along runways so built that they might be easily taken down and erected quickly again wherever they were required. The forms used for the concrete were all of the panel type. They were built near the work and the same sections used several times. They were made before the work was begun and grouped according to size, so that when they were needed they could be easily found and quickly erected. They were fastened together with bolts.

When the work on the tanks was completed the soil which had been excavated, and soil brought from other work, was spread over the top of the tanks to a depth of four feet. The bank on Keele Street was extended and neatly graded, and an easy slope was made from Bloor Street. The ground over the tanks and the slopes will probably be sodded and planted and possibly tennis courts, etc., arranged on it, making in all a very great improvement to this corner of High Park.

Costs.—The costs in hours' labor of this work, as kept by S. K. Ireland, B.Sc., resident engineer, are as follows:—

Excavation.—7,000 cu. yds., 10,472 hours, or 1.496 hours per cu. yd.

Placing Steel.—102 tons, 1,471 hours, or 14.4 hours per ton. (85 tons of this were bars and 17 tons mesh.)

Building and Erecting Forms.—52,899 sq. ft. took 8,452 hours, or 0.159 hours per sq. ft.

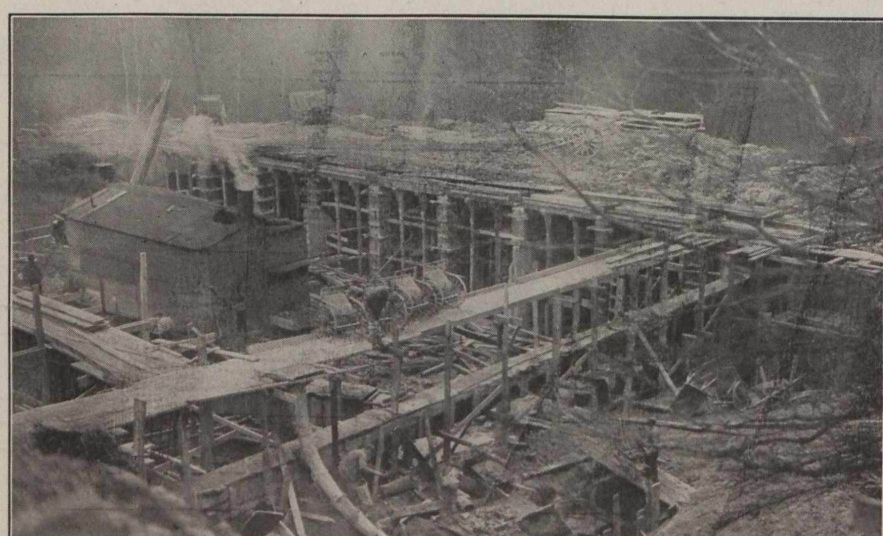
Removing Forms.—0.0202 hours per sq. ft.

Mixing and Placing Concrete.—2,522 cu. yds. took 6,394 hours, or 2.53 hours per sq. yd.

Foreman, 1,658 hours; engineer, 1,098 hours; fireman, 1,133 hours; team, 107 hours; single horse, 451 hours.

IMPERIAL OIL BUILDING.

At the corner of Church and Court Streets, Toronto, directly opposite to *The Canadian Engineer* building, foundations are being prepared for a large office building for the Imperial Oil Company, Limited. The structure will be of steel, with fireproofing throughout the seven stories and basement, all doors and trim being of steel, and windows of wired glass. The general contractors are Thompson, Starrett Company, 51 Wall Street, New York. Subcontracts have been let as follows: Structural steel, Dominion Bridge Company; masonry and fireproofing, Witchall & Sons; steel casements and trim, A. B. Ormsby Company; excavation, Ed. Corner, Toronto. The architects are Clinton & Russell, Dominion Bank Building, Toronto. The resident architect is Jas. L. Havill. The excavating contractor is using a revolving "Thew" shovel, 5/8 yard capacity, and a 12-h.p. "Beatty" hoisting engine, supplied by H. W. Petrie, Limited..



Showing Method of Disposing of Excavated Material; Also Runways for Concrete Barrows.

Editorial

THE KING HONORS CANADIAN ENGINEERS.

Engineers throughout Canada read the list of New Year's honors with the utmost satisfaction. It is doubtful whether the engineering profession in Canada has received ever before such marked recognition by our King. It augurs well for the prestige and social standing of engineers in this country, that three honors went to members of their profession, while the law received two; medicine, one; and finance, two.

Sir John Kennedy and Sir Collingwood Schreiber are the deans of Canadian engineering. Their knighthood is fully merited, and has been heartily acclaimed by all who are acquainted with them or their work.

To General Sir Alexander Bertram, *The Canadian Engineer* also proffers congratulations upon his well-deserved recognition. His long and distinguished career as an engineer and military officer is widely known. His capable organization of the shell-making facilities of Canada, which resulted in a saving of millions of pounds sterling to the British Government, in itself earned the honor he has received.

ONTARIO'S HYDRO-RADIALS.

Citizens of Toronto went to the polls last Saturday, and by their votes on a hydro-radial by-law, they gave engineers, contractors and machinery manufacturers the finest possible sort of a New Year's present. By a vote of nearly four to one, the taxpayers endorsed the agreement under which the city guarantees about $4,000,000 of the bonds of the proposed Toronto-London radial railway, to be constructed and operated by Ontario's Hydro-Electric Power Commission. By this vote the people of Toronto helped to make possible the future expenditure of upwards of one hundred million dollars on public improvements within the Province.

The Toronto vote was mostly a vote of confidence in Sir Adam Beck, and an expression of lack of confidence in the city council's ability to deal satisfactorily with Toronto's transportation problems. The average citizen probably knew little or nothing, and cared less, about the by-law which he ratified. He thought that private corporate interests opposed the by-law; therefore he was in favor of it. He felt that radial running rights through Toronto's streets are no more dangerous to his interests than are councilmanic vacillation and subdividers' schemes. But in voting for the by-law, he tied another string on corporate ownership of public utilities, and, incidentally, promised engineers and contractors in Ontario an immense amount of work within the next decade.

Not only will $14,000,000 be expended on the Toronto-London line, but that line will eventually be extended to Sarnia. Then there will be a line northward from Toronto, running to Collingwood, Barrie and Orillia, and possibly to Owen Sound. An easterly radial will run along the shore of Lake Ontario, right through to Montreal. All of these trunk lines will have feeder lines connecting the smaller towns.

Moreover, the endorsation of the hydro idea makes certain the construction of the proposed power plant at Niagara Falls. This will involve the early expenditure of $10,000,000. Another $5,000,000 or $6,000,000 will be added soon after the expenditure of the first ten millions, and eventually, including all expenditures, a 600,000 h.p. plant at the Falls will cost approximately $35,000,000.

At 6 per cent. interest, 5 per cent. depreciation, and 2 per cent. operating and maintenance cost (which figures are undoubtedly more than liberal), the annual charges on the $35,000,000 plant would be $4,550,000. But it would require fully $24,000,000 annual expenditure to produce that amount of power with the most modern kind of a steam plant. It is evident, therefore, that the hydro-electric resources at the Falls are well worth the proposed development by the Province, as they will yield power at a cost of less than $8 per h.p. per annum, compared with fully $40 for a steam plant. And while the price of coal continuously increases, Niagara will always flow as cheaply as ever.

THE RAILROAD SITUATION.

The net earnings of the Canadian Pacific Railway in November made a new high record for that month. The total was 140 per cent. ahead of November, 1914, 30 per cent. ahead of 1913, and 100 per cent. ahead of 1909. The gross earnings were the best for any November with one exception. Next to bank clearings (which in 1915 exceeded $900,000,000, the highest on record), there are probably no more important statistics than the earnings of the Canadian Pacific and other railways. These earnings at present indicate better business conditions and heavier traffic.

Those engaged in the manufacture of railroad equipment have had comparatively few orders during the past two years. Practically no renewals of rolling stock have been made, and but little new work has been undertaken. Considerable depreciation of locomotives, cars and general equipment has gone on without replacement. This means that work is accumulating which will require years to overtake when the war is over.

At present, many of the plants making rolling stock are busy with foreign orders. The latest to be received is for 2,000 freight cars, placed by the French government with the Canadian Car and Foundry Co. for delivery as rapidly as possible. Aside from such foreign orders, there are indications that domestic orders for equipment will be placed more frequently in the near future. Only last week, for example, a substantial order for locomotives for the National Transcontinental Railway was given by the Dominion government. This was made necessary by the prospect of a great wheat traffic, estimated at approximately 100 cars a day.

As to new construction of railroad mileage, terminals, improvements, etc., its extent depends largely on money market conditions. These have improved materially during the past few months. Confidence in Canadian securities is unshaken, and the railroads should be able this year to borrow funds for necessary work. Canada sold last year no less than $235,000,000 of its securities in the various money markets, and that sum does not include the $100,000,000 raised as a war loan within our own borders. Of the total loans raised by Canadian enterprises last year, over $33,000,000 was for our railroads. The amount that will be obtained by these borrowers during 1916 probably will be considerably greater.

EDITORIAL INDEX.

The index to articles in the editorial section of *The Canadian Engineer* for the half-year ending December 31, 1915, will be printed within the next few weeks, and distributed to all subscribers as an integral part of one of our regular issues.

CREOSOTED WOOD BLOCK ON GRADES.

By Andrew F. Macallum, C.E.
City Engineer of Hamilton, Ont.

WHEN the grade of a proposed pavement exceeds 3%, the question of a suitable pavement becomes of interest. With the variability of conditions to be met with, due to our climatic changes, the limits of most paving material are soon reached, so far as the inclination of grade is concerned.

The writer inquired from twenty-four cities to ascertain the maximum grades upon which creosoted wood block had been laid, and found that one city had laid this pavement on a 7% grade, one on 6%, three on 5% and five on 3% grades. The five to seven per cent. pavements were laid under two methods, described below.

The first method used was probably originated in Hamilton, and was used on upper James Street in 1909, on a 5½% grade. Each block had a piece ½ inch in width and 1 inch in depth cut off one face, so that while the blocks were laid at right angles to the centre line of the street, there was a space of ½ inch between each row of blocks, giving a good foothold for the horse-drawn traffic. These blocks were pitch-filled, and the cross grade of the street was sufficient to drain out any water.

The same method was adopted on King Street West, in Hamilton, the same year, and both of these pavements have been very successful in meeting the conditions of heavy traffic on two of our main streets, without a cent being spent for repairs or renewals since being laid.

The special cutting of the blocks in the manner described added considerably to the cost of the pavement, and to obviate this, the ordinary rectangular block has been used, with creosoted laths ⅜″ x 2″ laid between each cross row of blocks. This is pitch-filled as in the first method, and has been just as successful. A part of John Street South and Bay Street, each having a grade of 5½%, paved in 1911, were laid in this manner, and are to-day in first-class condition and subjected to fairly heavy traffic.

On Ravenscliffe Avenue, a purely residential street, having 6% grade, blocks spaced in this manner were laid. The reason for putting such a pavement on a street like this, having very little traffic, was that the residents insisted on a creosoted wood block pavement because of its quietness, and it has fulfilled expectations.

CANADIAN HIGHWAY DEVELOPMENT; WITH NOTES REGARDING ONTARIO'S SYSTEM.*

By William A. McLean,
Chief Engineer of Highways, Province of Ontario.

ROADS in nearly all countries fall naturally into a three-fold classification. There are main roads between towns and cities; leading farm roads, radiating from market centres and shipping points; and local feeders. The natural features of any country have been very largely a controlling factor as to which of these classes of roads has received first or chief attention.

Thus, in the province of British Columbia, traversed by the Rocky Mountains, with rich resources of mine and forest, and fertile valleys, the construction of main roads connecting centres of population has been a feature of the provincial road programme, and upon which there has been a recent expenditure of about $15,000,000.

The prairie provinces of Saskatchewan, Alberta and Manitoba, principally agricultural, with very little road material, constitute an area of earth roads, in which the grader and log-drag are to the present, the principal means of improvement. Nevertheless, their expenditure on roads and bridges amounts to about $2,500,000 annually.

The province of Quebec is making a special expenditure of $15,000,000 on road improvement. A portion is being granted as aid to municipal construction; but in addition a considerable mileage of main road has been built which will provide an excellent tourist route when completed in 1916. The trunk of this main road system under the control of the province will consist of a route from the American boundary near Plattsburgh, in New York State, thence northerly to Montreal, 39 miles; a road on the north shore of the St. Lawrence easterly to Quebec city, 151 miles (in addition to 27 miles of existing toll roads); and from Quebec city south to the American border near Jackman, in Maine, 92 miles. Another "regional" road reaches from Sherbrooke to Derby Line on the American border, a distance of about 33 miles. On this system of trunk roads nearly $4,000,000 has been spent by the province. A feature of the Quebec aid to municipal construction is that, for substantial improvement, the government will provide the necessary capital, charging the municipality 2 per cent. for a term of 41 years, the government meeting the balance of interest and sinking fund. About $8,000,000 has been thus appropriated to the present time.

Prince Edward Island, the small island province in the Gulf of St. Lawrence, a fertile agricultural area, is principally concerned with earth roads, all under the the direction of a provincial department.

New Brunswick is not as yet making any large expenditure, although the beneficial influence of a provincial office is being exerted.

Nova Scotia, the most easterly province facing the Atlantic, is not in a position to make large expenditure; but the Provincial Department of Public Roads is making excellent progress with the outlay available, more especially in the improvement of earth roads, and the construction of permanent culverts and bridges. The expenditure

*Abstract from paper read December 14th, 1915, at Worcester, Mass., before the First International Road Congress. This congress was organized by the Worcester Chamber of Commerce. The registration exceeded 600, including the following Canadians: Controller Cote, Montreal; U. H. Dandurand, Montreal; J. W. Levesque, M.L.A., Montreal; G. A. McNamee, Montreal.

of that department for the year just ended will amount to about $635,000.

Southern Ontario is probably the most densely occupied portion of Canada. In an area of about 40,000 square miles there is a population of about 2,500,000, one-half of which is urban and the other half rural. In this southern and populous portion, which is chiefly agricultural, there is a municipal expenditure on roads in the open country of over $2,000,000 annually, while the province spends about $1,500,000 annually through three road departments, *viz.* :—

(1) Subsidies to leading market and main roads in Southern Ontario.

(2) Trunk colonization roads in Northern Ontario.

(3) Minor colonization roads in Northern Ontario.

No part of Canada is so favorably placed to finance the construction of main roads as are some portions of the United States—such States as Massachusetts, Connecticut, or New Jersey, which are small in area and contain numerous cities which contribute to the cost of rural roads.

Unfortunately, and unlike the United States, the system of municipal organization has been such that all cities are wholly separated from the county and township in which they lie, and have escaped taxation for roads in the open country. This is a situation which recent legislation has sought to correct; and provision is being made that all cities shall contribute to the cost of leading roads within a reasonable suburban area.

County Roads in Ontario.—Owing to the strong claims of agricultural communities, the assistance given by the Provincial Government to the better class of construction has been largely confined to the subsidizing of leading market roads in each county.

Ontario has both township and county organization. Township councils are elected annually, and the reeve of each township is, ex-officio, a member of the county council. Township councils, primarily, have control of all the roads, but a county council is authorized to take over from the townships the leading roads of the county for construction and maintenance. To this system of county roads the Provincial Government has heretofore paid one-third of construction cost only, but under legislation of the past year, will hereafter contribute 40 per cent. of the cost of construction, and 20 per cent. of the cost of maintenance. More than half of the counties are operating under this plan with good results, and to the present time, a total of over $6,000,000 has been spent on the work. It is anticipated that, under the increased subsidy, the remainder of the province will adopt county systems in a very short time.

Counties have been somewhat lethargic in adopting the plan; but, having adopted it, and having completed a reasonable mileage, the method becomes very popular. Property along the improved roads has shown decided advance in value varying with local conditions from 10 per cent. to 40 per cent.

A favorable feature of the Ontario scheme is that, by requiring counties, at the initial stage, to adopt a comprehensive plan of roads, a well connected system finally results. The work is very often, to meet local feeling, carried on in short sections, but each successive council has a permanent plan on which to work. Construction is carried on under an engineer or superintendent appointed by the county council, but all is subject to the regulation and inspection of the Provincial Department of Highways. The provincial subsidy is paid annually as the work progresses.

A county council may issue 30-year bonds to meet its own proportion of the cost, but more commonly they extend over a 20-year period. Very seldom are bonds issued for the entire expenditure of the county, but as a rule to supplement a sum raised by uniform county rate. A county system will usually include about 200 miles, or 15 per cent. of the total road mileage within the county. The completion of such a system may extend over eight or ten years, so that by levying a county rate of 1.5 mills annually on the assessment during that period, only a very small municipal debt need accrue. Largely for moderate farm traffic, the county roads are of gravel or broken stone, single track, except near cities, and cost from $2,000 to $8,000 per mile, according to local conditions and traffic.

Assuming a county system constructed in ten years at a cost of $800,000 with a county assessment of $30,000,000, the annual arrangement would be as follows:

Direct levy of 1½ mills on assessment	$45,000
Bond issue	3,000
Provincial subsidy, 40 per cent. of total	32,000
Total	$80,000

Thus, in ten years (with proper maintenance additional), the county would have an asset in road improvement of $800,000, with a bond issue of only $30,000. To the latter is commonly added the cost of heavy machinery and permanent bridges, on which the provincial subsidy of 40 per cent. is also paid.

Bond issues for county roads are met on the annuity instalment plan. The sinking fund method has been almost entirely abandoned in the province for all municipal purposes, except in the larger cities. The annuity instalment plan is cheaper than the sinking fund method, safer, more easily managed, and is distinctly in favor with financiers, municipal authorities and the public.

Main Roads in Ontario.—Under new legislation for main roads, more attention will be given to the development of certain trunk lines, for which there is a growing demand. The chief of these connects Ottawa on the east with Windsor on the west, a distance of about 500 miles. A branch, 75 miles in length, would reach to the Quebec boundary, and another would reach from Hamilton to Niagara Falls, 45 miles. This road would form an ideal trunk highway for the southern part of the province. It would link up the various systems of county roads, would pass through the most important cities, and within 12 miles on each side is about one-half the population of the province. Some portions of this road are now in fair condition, with good gravel or broken stone surface.

The most important section, about 36 miles between Toronto and Hamilton, is now being constructed in a thoroughly substantial manner, with 4 per cent. grades, 26 feet between shoulders, and an 18-foot concrete pavement. The cost of the Toronto-Hamilton section will be about $850,000 and the work is to be completed in 1916. Other portions of the highway are now under consideration, and the linking up of the entire trunk highway is, it is believed, merely a matter of reasonable growth.

The system of management provided for this class of road is somewhat unique. A main road is interpreted as one running directly between two important terminal points or cities, and therefore passing through a series of municipalities. Such series of municipalities may petition the Provincial Government for construction as a main road; and if the petition is endorsed by three-quarters of the municipalities affected, the government will make surveys, prepare specifications and appoint a special board of commissioners to take charge of the construction and maintenance of the road. The cost in the engineer's report is apportioned among the municipalities benefited (the government contributing 40 per cent., but not exceeding $4,000), and the commissioners then act as a Court of Revision to hear the appeal of any parties affected as to the engineer's apportionment of the cost. The commission may confirm or revise the engineer's report, and unless a majority of the municipalities then petition against the work, the commission is authorized to proceed with construction.

The plan of having a local commission for each main road is no doubt a weakness in one respect, in that one permanent commission for the entire province would bring greater experience and knowledge to each successive work; but on the other hand, the municipalities pay the greater part of the cost; they have, and are accustomed to, good local self-government; and "taxation without representation" is a principle which it is desirable to avoid. When a series of main roads is constructed, the tendency will no doubt be to unite them for maintenance under one commission. The plan was adopted at the last session of the Legislature and its efficiency has yet to be proven.

Classification in Ontario.—It will thus be seen that, in the Province of Ontario, the three-fold classification, so desirable in road organization, is being evolved in the following manner:—

(1) Main or trunk roads to be constructed and maintained by special commissions, under the guidance of the Provincial Highway Department; the cost to be met by provincial subsidy, and direct assessment on cities and rural municipalities benefited.

(2) Leading market roads, to be under the control of county councils, subject to regulations and inspection of the provincial authorities; the cost to be met by provincial subsidy, and county levy on all assessable property within the county, including cities.

(3) Local feeders, to be under the control of township councils, and at the expense of the township.

What Will Good Roads Mean?—In Canada there are about 250,000 miles of graded roads. Road-building is a slow process, and in most countries it has taken half a century at least to provide adequate surface construction. The immediate objective in Canada should be to substantially improve about 16 per cent. of the total, or 40,000 miles, which would carry the more concentrated market or farm traffic, while about 2 per cent. additional, or 5,000 miles, should be treated in a trunk road basis. The total cost might be approximately estimated at $250,000,000, of which about $50,000,000 has been spent. The ideal of expenditure to be aimed at for this work of main road improvement (apart from small repairs and maintenance) would be about $15,000,000 annually, or $2 per capita of population.

This is a substantial programme for a population of 7,500,000 people. It indicates one reason why road-building is a slow process—because it is expensive. It means that the work must be distributed over a term of years and among various administrative organizations. But, so distributed, and looked at from the standpoint of annual ability, the undertaking becomes less difficult. The total twenty-year cost of maintaining a household does not worry the average man—if his annual income is sufficient for the annual outlay. Road-building is a continuous work; if properly carried on, is cumulative in its growth, and is a question of annual expenditure available to meet direct outlay, plus sinking fund, interest and cost of maintenance.

Canada is a country of rich and varied resources. But natural resources are of value only as they are developed. A considerable part of the cost of such development is in transportation. The lessening of the cost of transportation, is a measure of economy, of national thrift, which will produce a large return on the expenditure. On this continent, the cost of team haulage is rarely less than 25 cents per ton-mile and is sometimes twice that amount. Under the favorable conditions of good roads in Europe, the cost is reduced to between 8 and 12 cents a ton-mile.

The tonnage carried over the country roads of Canada is not readily estimated; but railway statistics show that the total amount of freight carried by the railways and originating in Canada, is about 60,000,000 tons. This, for the most part, at one or both ends of the railway journey, must pass over the wagon road. And a considerable additional amount, consumed locally, passes over the wagon road without railway transportation. The average wagon haul for farm and natural produce is estimated at between seven and eight miles. It is probably a moderate assumption for Canada that a total of not less than 100,000,000 tons passes over the roads of the country with an average haul of five miles. If, then, the premise is true that good roads would effect a saving of ten cents per ton-mile, an adequate system of improved roads would create a profit of $50,000,000 annually on the produce and merchandise now passing over them.

The time lost in travelling over bad roads is very great. It is a fair estimate that bad roads occasion a loss of a man and team for 12 working days annually to the average farm. With over 700,000 occupied farms in Canada, this wasted time and effort, if put into road construction, would substantially macadamize the leading market roads in less than ten years.

EFFECT OF CAR LINES ON REAL ESTATE VALUES.*

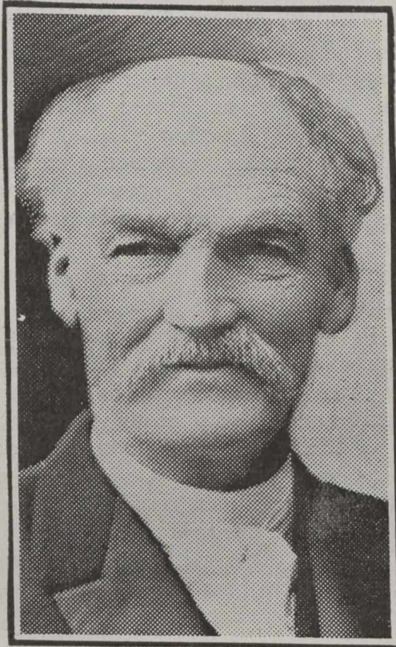
Investigation in Toronto and American cities, notably New York and Philadelphia, has demonstrated that the institution of transportation service, leads almost immediately to largely increased population in the territories served, and to largely enhanced real estate values.

Between the five years comprising 1910 to 1914, inclusive, the city of Toronto constructed approximately 18.28 miles of single track railway on Gerrard Street, Danforth and St. Clair Avenues, and Bloor Street West. An examination of the registry office records, shows that in the area within the city limits which one might reasonably estimate as being benefited by transportation, 1,525 representative property transfers, were abstracted, which show, in comparison with the sale figures of 1910, an increase of 134 per cent. in property values, integrated over the aforesaid period. During this term the average assessment per acre of the city shows an increase of approximately 66 per cent. Deducting this figure from the 134 per cent., leaves an increase in value of 68 per cent. attributable mainly to civic car line operation.

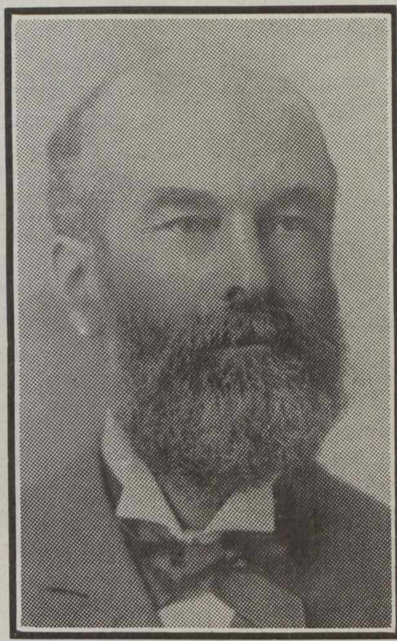
It may be argued, that the widening of Danforth and St. Clair Avenues, respectively, is responsible for a portion of this latter increment, but in compiling these figures, we have been careful to ignore transactions covering properties fronting on the aforementioned thoroughfares, the values of which, were without doubt, largely augmented by reason of the widening. If the cost of the car lines, excluding the frontage on Gerrard Street, Danforth and St. Clair Avenues, had been assessed by local improvement over the properties directly benefited thereby, the entire levy, exclusive of added charges on account of the extended life of the bonds, would have amounted to about 6 per cent. on the original investment as of 1910, or 4½ per cent. upon the increase in value during the 1910-1914 period. During the last mentioned period, the population in the districts aforementioned increased 131%.

*Excerpt from Toronto Rapid Transit Commission's report.

Canadian Engineers Honored by the King



SIR COLLINGWOOD SCHREIBER,
General Consulting Engineer to the Dominion Government.



SIR JOHN KENNEDY,
From a photo taken when he was president of Can.Soc.C.E.

SIR ALEXANDER BERTRAM,
Brigadier-General; Vice-Chairman of Imperial Munitions Board.

Three members of the Canadian Society of Civil Engineers were honored this week by the King. In the New Year's list appear the names of Sir Collingwood Schreiber, K.C.M.G.; Sir John Kennedy, K.B., and General Sir Alexander Bertram, K.B.

Sir Collingwood Schreiber was born in 1831 at Bradwell, Essex, England. He was educated in England, and came to Canada in 1852. Until 1856 he was assistant engineer of the Hamilton and Toronto Railway; 1856-1860, superintending engineer Toronto Esplanade; 1860-1864, Northern Railway of Canada; 1869, division engineer in charge of surveys, Intercolonial Railway; 1870, superintending engineer for Canadian Government on Eastern Extension Railway of New Brunswick; 1870-1873, assistant chief engineer, Intercolonial Railway; 1873-1878, chief engineer, Canadian Government Railways; 1880-1892, chief engineer, C.P.R.; 1892-1905, deputy minister of railways and canals; 1905 to date, general consulting engineer to the Canadian Government.

He is one of the charter members of the Canadian Society of Civil Engineers, and served on the council of the society during the first two years of its existence. At present he is an honorary member of the society. Although 84 years of age, he is still very active in the discharge of his duties, and a few weeks ago completed a tour of inspection which extended to the Pacific Coast.

Sir John Kennedy was born at Spencerville, Ont., in 1838. He was educated at Bytown Grammar School and McGill University. In 1871 he was division engineer on the construction of the Wellington, Grey and Bruce branch of the Great Western Railway. In 1875 he became chief engineer of the Montreal Harbor Commission, a position which he held until 1907, when he became consulting engineer. This position he now holds.

He takes a lively interest in all that concerns engineering in Canada, and rarely misses a meeting of the Canadian Society of Civil Engineers. He was one of the founders of that society, and the popularity that he still retains among its members, was early shown by his election as the fourth president of the society. He was vice-president of the society the year it was organized, and was a councillor for the three years following, until he was again elected vice-president in 1890 and 1891. In 1892 he became president, following T. C. Keefer, S. Keefer and Sir C. S. Gzowski in that position. In 1900 he was again elected councillor, and retained that position for eight years. He is the oldest living past-president of the society, and in 1907 was made one of the nine honorary members.

Sir Alexander Bertram was born at Dundas in 1853. He became a partner in the Canada Tool Works in 1886, and has ever since been connected with The John Bertram Sons Co., of Dundas. When war was declared he was acting as manager at Montreal for that concern. He has been an officer in the Canadian militia for many years. He is a noted rifle shot, and in 1909 was commander of the Bisley team. Some time ago he received the officer's decoration of the Colonial Auxiliary Forces.

When Sir Sam Hughes formed the Canadian Shell Committee, General Bertram was made chairman, and his work attracted the attention and praise of all Imperial authorities. D. A. Thomas, who was Lloyd George's commissioner to Canada, several times stated that Canada and the Empire owed General Bertram great gratitude for his untiring work, night and day, without remuneration, in mobilizing Canada's industries for the manufacture of shells. When further shell production became a financial rather than a manufacturing problem, the Imperial Munitions Board, composed mostly of financiers, succeeded the Canadian Shell Committee, but General Bertram's services were retained as vice-chairman of the new board. He was elected a member of the Canadian Society of Civil Engineers in 1911, and has taken considerable interest in the society's meetings. His name appears on the list of contributors of papers published in the transactions of that society.

PROGRESS IN ASPHALT REFINING; WITH NOTES ON MEXICAN ASPHALTIC CRUDES.*

By Leroy M. Law,
Chief Chemist, the United States Asphalt Refining Co.

THE merits of refined asphalt roads quite naturally resolve themselves into the merits of the asphalts used in their make-up, for, in the same type of construction, the mineral aggregates, their preparation, etc., will be practically the same for all asphalts. Let us consider, then, these changes which have been brought about in petroleum asphalts that enable one to discuss roads built from these materials, not as possibilities, but in the light of actual reality.

Petroleum doubtless entered the paving industry as a "flux," or softening agency, for the solid, native bitumens, which were too hard to be used for paving purposes in the condition in which they naturally occur. These fluxes were not straight mineral oils, but the residue of by-products of oil distillation, for in those days the major products of all refineries were the burning oils, and later on, gasolines and lubricants. The fluxes were, therefore, what remained in the still after these more valuable fractions had been taken out, and, under the name of "residuum," were generally considered as containing the lubricating oils, waxes and pitch base. That they were actually refuse products, with little or no care in regard to their quality, is shown by the fact that the oils were frequently subjected to so called "cracking" processes for an increase over the normal yield of burning oils, etc., this to the detriment and injury of the residuum.

There are about six more or less well-defined oil fields in this country, and in some of them the oils vary from well to well, yet all were distilled for practically the same major products. It was, therefore, not surprising that the resulting residues were variable in character, and doubtless many times unsuited even for the purpose of fluxing the hard asphalts. Under such circumstances, however, petroleum asphalts originated.

The increasing use of the more successful native bitumens early became the stimulus for the development of the residuals so that they might be placed in competition with the asphalts, to which they heretofore had served only as adjuncts, and, to do so, it was necessary that they be brought from their more or less fluid state to consistencies suitable for paving purposes.

It was early found that distillation of the paraffine and semi-asphaltic petroleum beyond the "residuum" stage, resulted in decomposition of the pitch or asphalt residues to such extent that their usefulness as paving materials could not receive serious consideration; so other means were sought to achieve the desired end. For example, it was found by Dubbs that the addition of sulphur to the residuum, maintained at elevated temperatures, resulted in a molecular condensation, with liberation of sulphuretted hydrogen gas. The resulting artificial asphalts received the name of "Pittsburgh Flux," and proved to be interesting products.

Byerly, working about the same time, found, too, that by blowing air through the heated residuum, the oxygen performed a similar function to the sulphur in the Pittsburgh flux, and in 1893 took out a patent covering the air-blowing process. This proved a most important step in the transition of petroleum asphalt, for air blowing was cheaper than sulphur, and by regulating the duration of the "blow," asphalts varying from soft to hard consistencies could be produced.

Another step in the evolution of asphalts from petroleum was accomplished by compounding with the distillation residues such quantities of hard bitumens, like gilsonite and grahamite, as to produce materials of paving consistencies. Many of these compounds contained as much oil as hard bitumen. On account of the large percentage of the oil residuum required the original element of uncertainty still prevails in regard to the finished product. This, together with the high price of gilsonite and grahamite, and other factors, has doubtless served to greatly restrict the use of such preparations to-day.

This brings us up to about the year 1900, previous to which the oil asphalts were truly artificial materials. They were prepared at best from oils of low asphaltic contents, and their solidity and consistency were proportional to the artificial means employed in their manufacture.

Asphalts from Texas and California petroleum next deserve our attention, and it is interesting to note that, while they differed widely in characteristics, both are still in use to-day, though doubtless in modified form. The original Texas asphalts were low in susceptibility to temperature changes, but low ductility retarded their adoption by many cities which were maintaining a minimum ductility requirement of 15 or 20 centimeters in their specifications.

On the contrary, the California materials possessed practically unlimited ductility. Their advent was the turning-point in the evolution of petroleum asphalts, inasmuch as their preparation could be accomplished by a simple refinement direct to the desired consistency without any air-blowing.

Mexican petroleum entered the field of raw materials five years ago. The asphalts produced therefrom met successfully recognized paving and road oil tests, and a plentiful and uniform supply of the raw material is assured. Mexican asphalts, it is true, had appeared in the paving industry years ago, but the early examples were but the more or less solidified effusions from the real supply, which lay thousands of feet below the surface.

In 1910, therefore, the opening of several large wells on the east coast of Mexico began a new epoch in the asphalt business. Two types of Mexican petroleum constitute, in general, the supply of crude material brought to this country: a heavy oil of 10° to 12° Beaume gravity, carrying about 70 per cent. of asphalt, and a lighter one of 18° to 21° gravity, with an asphalt content of 55 to 60 per cent. These issue from wells of 3,000 to 5,000 feet

*Abstract from paper read at Worcester Convention, December 16th, 1915, and entitled "Merits of Refined Asphalt Roads."

depth, are collected in large storage tanks, or sometimes in earthen ponds or lakes, then are pumped into specially constructed tank-ships, ranging from 30,000 to 60,000 barrels in capacity, for transportation to the refineries of this country.

Both oils yield excellent paving materials; their high asphalt contents and correspondingly low percentages of light oils enable their refinement to be accomplished promptly and with a minimum risk of injuring the asphalt residues, which, in the handling of Mexican petroleums, are the major products of the refinery.

With both types of crude, furthermore, it is commercially practicable to stop the refining or reduction process at any stage of consistency between the fluidity of the natural liquid and the solidity of hardest paving cement, so as to give the engineer a material made by one simple process to the consistency he desires. By such procedure the natural fluxes are retained, and he is relieved of subsequent artificial fluxing with its attendant losses in time.

For paving cements and road binders there is apparently a preference for products of the heavier oils, doubtless on account of their greater density and lower paraffine content, but the lighter oils, however, serve as the chief source for road surfacing materials. When simply freed from moisture and sediment they serve as a cold surface dressing for macadam roads, the naturally occurring gasoline which they carry serving as a natural thinner to facilitate penetration into the road structure. Deprived of these lighter oils to greater or less extent, they serve in excellent manner for the more permanent and so-called hot surface applications.

A high asphalt content, with a corresponding reduction in the amount of burning oils, resulted in a complete change of purpose, and what was the "residuum," or residue, became the major product. This radical change in petroleum refinement has brought forth several new processes, among which may be mentioned those covered by the Dundas and the Trumbull patents. Both are of California origin, the former little used, but the latter in successful operation with both California and Mexican oils, and worthy of mention.

Its operation depends on pre-heating the oil, then pumping it to the top of heat-jacketed cylindrical towers, down the inner surface of which it is allowed to flow in a thin sheet of stream. Around a central vertical standpipe, or "off-take," are openings for the vapors or light oils to pass on their way to the condensers. These openings are protected by conical or umbrella-like shields so that they will not be clogged by the asphalt as it passes on its way to the bottom of the tower. The temperature employed and the rate of pumping determine the consistency of the asphalt.

The most generally used process, however, is that of steam distillation, which removes the lighter oils from the associated materials at temperature below their normal boiling points.

While these oils would require temperatures as high as 900° or 1,000° F. for their actual distillation, the steaming process enables them to be removed as low as 600° to 650° F., for in the best-regulated plants the asphalt in the still is never allowed to exceed such temperatures.

In the best-regulated plants recording pyrometers indicate the actual temperatures at all times, and when careful tests show that the desired consistency has been reached the charge is allowed to cool, then pumped to storage or drummed for shipment.

COAST TO COAST

Vancouver, B.C.—It is expected that work on the construction of the new grain elevator will be completed by the end of January.

Edmonton, Alta.—George Webster, contractor for the Grand Prairie branch of the Edmonton, Dunvegan and British Columbia Railway, states that the grading of the line is completed and ready for the steel.

Calgary, Alta.—All the plans, profiles and field work records of the proposed $3,000,000 Elbow River waterworks system are said to be missing from the city's vaults. These records cost about $10,000. Various theories are advanced to account for their disappearance.

Quebec, Que.—The new branch line of the Quebec Central Railway, twenty-five miles in length, extending from St. Camille, Bellechasse County, to English Lake, was officially inspected last week by Hon. A. Taschereau, Provincial Minister of Public Works.

Hamilton, Ont.—The report of City Engineer A. F. Macallum, recently submitted to the city council, shows the following amount of local works completed during the year: 4.7 miles of sewers; 5.1 miles of cement walks; 2.6 miles of curbs; 7.3 miles of asphalt pavements.

Fort William, Ont.—According to the report of City Engineer R. R. Knight, $24,198 was expended on streets and sewers in 1915, as against $42,683 in 1914. Local improvement works which were initiated last spring cost the city $39,754, and the laying of a feeder main to the west end of the city cost $57,393.

Kingston, Ont.—City Engineer R. J. McClelland reports that he carried out the following work by day labor during 1915: 2¾ miles concrete walks; ⅓ mile sewers; ½ mile concrete curb; 6 blocks asphaltic macadam pavements; macadam roadway; resurfacing of macadam roadways with Tarvia.

Toronto, Ont.—At noon on December 24th, the dredging work in the Toronto Harbor closed for the season. Work was carried on for about two weeks later than it was in 1914. During the winter season the equipment will be overhauled and all preparations made for active work early in the spring.

Welland, Ont.—Major James Sheppard, superintendent of roads for Welland County, has submitted a report to the county council which shows that approximately 41 miles of new road were constructed last year—21.39 miles by the county and 19.67 miles by the contractors. The total mileage of improved road on the county system is now about 82 miles.

New Westminster, B.C.—M. H. MacLeod of Winnipeg, general manager of the Canadian Northern Railway Company's western lines, has announced that his company will commence work early this year on the construction of a line from the north end of the New Westminster bridge over a right-of-way which it has acquired through this city to a station to be built here.

West Kildonan, Man.—According to the report of Engineer Eatwell, local improvements costing $330,529.36 have been completed during the past eighteen months, including Main Street paving, 1½ miles, $58,796.31; Main Street concrete sidewalks, 1¼ miles, $8,000; trunk sewer, 1 mile, $113,646.57; lateral sewers, 6.1 miles, $58,211.05; water mains, 7.15 miles, $79,294.74; fire hall, $7,200.

Montreal, Que.—According to a statement made by H. P. Borden, assistant to the chief engineer, work on the Quebec bridge, which was started eight years ago, will be completed by next December. It is expected that by October next the great suspended span, which is 640 feet long, and weighs 6,000 tons, will be floated to its place. When finished, the bridge will have cost about $17,000,000.

Hespeler, Ont.—Work was completed last week on the installation of the waterworks system, the contract for which was awarded last June to John Hartnett, of Toronto. The reservoir has a capacity of 200,000 gallons, and is fed from two artesian wells. The standpipe, supplied by the Pittsburgh and Des Moines Steel Co., Pittsburgh, Pa., has a capacity of 100,000 gallons, and gives a working capacity of from 20 to 100 pounds pressure.

Winnipeg, Man.—Mr. J. D. McArthur, of Winnipeg, who is building the Hudson Bay Railway from Le Pas to Port Nelson for the Dominion Government, states that the line is now graded within forty miles of Port Nelson, and that steel is laid to Manitou Rapids, 190 miles from the terminus. Work has started on the erection of the steel bridge and will be completed in the spring. It is expected that the road will be finished to the Bay by next fall.

Toronto, Ont.—The recommendation of Parks Commissioner Chambers that the Humber Valley boulevard be constructed on the high land east of the river, rather than in the river valley, has been adopted by the parks committee. The agreement between Home Smith and the city in connection with the Humber Valley improvement scheme provides that the city spend $25,000 a year for six years. To date the city is about $14,000 behind in the amount that it should have expended, and Mr. Smith has urged that some definite action be taken towards completing the proposed roadway.

Point Grey, B.C.—According to a report issued by Municipal Engineer Greig for the year ended December 15th, 1915, much important work has been accomplished, including the grading and paving of the University Avenue division, the paving of Yew Street from Forty-ninth Avenue, and the completion of the portions of Oak Street, which were commenced in 1913. The report shows the total mileage of permanent street pavement in the municipality as 17.11 miles; total miles of streets rocked, 50.32; roads graded, regraded and contoured, 69.72, 4.22 miles of which were done last year; roads cleared, 55.66; lanes cleared, 43.88; cement concrete sidewalks, 29; sewers constructed, 53.50 miles; sewer connections made, 14.493; storm water drains laid, 10.74; and water mains laid, 106.116. During the year, 1.69 miles of sidewalks were laid; 96 miles of permanent street pavements laid; .57 miles of streets rocked; .66 of roads cleared, and 1.7 miles of water mains laid.

PERSONAL.

HARRY McAVOY has been elected a member of the Hydro-Electric Commission of St. Catharines, Ont.

P. A. McDONALD, of Winnipeg, has been appointed Public Utilities Commissioner for Manitoba, succeeding H. A. Robson, who has resigned.

RUFUS H. MARTIN, of New Glasgow, N.S., has been appointed assistant district superintendent of the eastern division of the Intercolonial Railway.

ROBERT GEORGE KYD, town engineer of Dunnville, Ont., has been elected an associate member of the Institution of Civil Engineers of Great Britain.

FRANK E. WATKINS, formerly associated with the Canadian Fairbanks-Morse Co., Limited, Toronto, has been appointed works manager of the East Jersey Pipe Corporation, Paterson, N.J.

FRANK P. JONES, general manager of the Canada Cement Co., and who formerly occupied a similar position with the Dominion Steel Corporation, has again joined the steel company in the capacity of a director.

GEORGE S. MICHEL, formerly assistant director of Public Works of the Province of Quebec, has been appointed engineer and director of public works by the Quebec Government, to succeed E. Charest, who has retired.

G. W. CAYE, assistant to Morley Donaldson, vice-president and general manager of the Grand Trunk Pacific, has been appointed purchasing agent of the Grand Trunk System, with headquarters at Montreal, succeeding J. G. Guess, who has resigned.

Lieut. RALPH HARRIS, formerly of the Toronto Roadways Department, and a graduate of the School of Practical Science, Toronto, has been wounded and is now in a Boulogne hospital. Lieut. Harris enlisted in the Corps of Guides, and later joined the Canadian Artillery. In England he was transferred to the Royal Engineers.

COMING MEETINGS.

AMERICAN FORESTRY ASSOCIATION.—Annual meeting to be held at Boston, Mass., January 17th and 18th, 1916. Secretary, P. S. Ridsdale, Washington, D.C.

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.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—The Twelfth Annual Convention to be held in Chicago, January 18, 19 and 20, 1916. Chas. C. Schnatterbeck, chairman, Committee on Publicity and Promotion, American Wood Preservers' Association, Baltimore, Maryland.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—The Thirtieth Annual Meeting to be held in Montreal, January 25, 26 and 27, 1916. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—To be held in Chicago, Ill., February 4th, 1916. Joint dinner that evening with American Electric Railway Manufacturers' Association.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Second National conference to be held at Chicago, Ill., February 15th to 18th, 1916. Secretary of Advisory Committee, J. P. Beck, 208 South La Salle Street, Chicago, Ill.

AMERICAN CONCRETE PIPE ASSOCIATION.—Annual Convention to be held in Chicago, February 17 and 18, 1916. Secretary, E. S. Hanson, 538 S. Clark Street, Chicago, Ill.

CANADIAN LUMBERMEN'S ASSOCIATION.—At Ottawa, February 18th, 19th and 20th, 1916, annual convention. Frank Hawkins, secretary, Ottawa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—At Sohmer Park, Montreal, March 6th to 10th, 1916. Geo. A. McNamee, secretary, New Birks Building, Montreal.