PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Are Good Roads Remunerative to Municipalities?

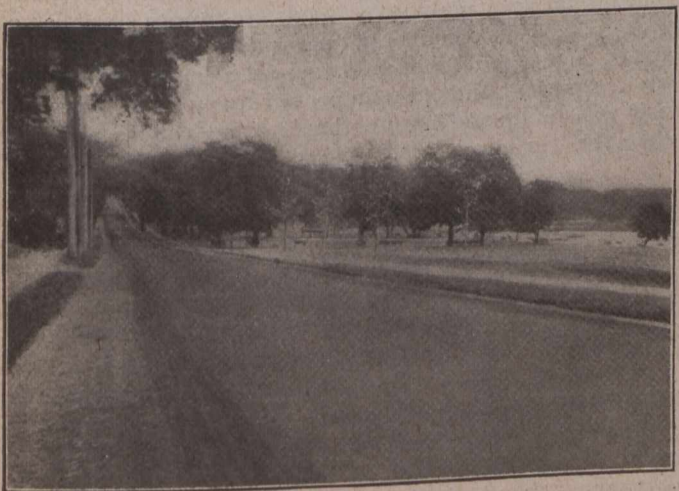
Experience in Massachusetts Throws Some Light Upon the Question, Do Good Roads Pay?—Increased Amounts of Taxes Are Collected Due to Rise in Land Values Directly Caused by Road Construction

By COL. WILLIAM D. SOHIER
Chairman, Massachusetts Highway Commission

WHEN I attended the Canadian Good Roads Congress at Hamilton last week, I gave some statistics regarding the value of good roads—their actual dollars and cents value—which the representative of *The Canadian Engineer* thought were interesting, and he made me promise to write an article giving some more detailed data in answer to the question, "Do good roads pay?"; or more exactly, to the question, "Are municipalities remunerated for their expenditures on good roads by the increased taxation due to rise in land values occasioned by the construction of the roads?"

To begin with, I will cite some experiences we have had in Massachusetts. The figures I will quote are in round numbers. I have left off the hundreds and sometimes the thousands, because they are of no value, comparatively speaking.

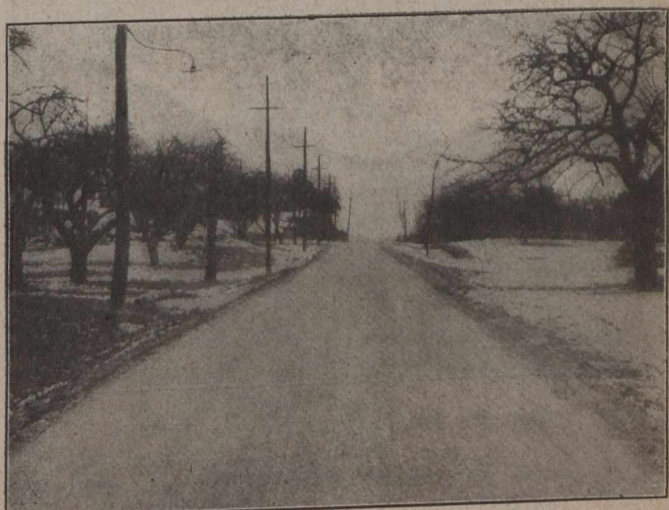
We must realize that there are so many considerations other than roads that may enter into increased land values, that it would be very difficult to prove that all of these increases were due absolutely and solely to better roads. At the same time, there is no doubt in my mind that good roads have been very largely responsible for the increases in valuation, and particularly in localizing them in places which have become favorite summer-resident resorts, the



Lathrop Road, Near Beverly, Mass.

particular portion of the town that was served by good roads having developed and other equally good localities on the seashore, for instance, not having developed; though, of course, this does not show in the valuation of the town.

In Massachusetts, the municipalities of Beverly and Manchester had good roads really back as far as 1895 and thereabout. Wenham, Hamilton and Ipswich were also connected up with improved roads. Essex, lying between Hamilton and Gloucester, has some fine beaches, sand dunes, and a river, but the road has not yet been built.



Massachusetts State Highway, South Sudbury

The following are the valuations in 1900 and 1915 respectively, with the percentage of increase:—

	1900.	1915.	Percentage increase.
Beverly	$16,000,000	$44,000,000	175
Hamilton	2,299,000	6,000,000	161
Ipswich	3,245,000	5,634,000	73
Topsfield	859,000	4,294,000	400
Middleton	569,000	923,000	62
Wenham	1,000,000	3,662,000	266
Manchester	8,700,000	20,000,000	129
Essex	977,000	1,315,000	34
Boxford	688,000	1,338,000	94½
Newbury	979,000	1,600,000	63
Georgetown	1,000,000	1,365,000	36½

Beyond Ipswich is Newbury, which was not connected up on a through route until lately. Beverly, Wenham, Hamilton and Ipswich are all connected with a good road; hence their valuations. Hamilton, Wenham and Ipswich are farming towns, although Ipswich has a little seashore.

Topsfield was connected with a good road to Hamilton in the year 1900. It is also a farming town, as is Georgetown. Two other towns only just connected up with improved roads, are Middleton and Boxford.

Improvements on Cape Cod

Improved roads were built in Bourne, Yarmouth and Barnstable by 1900. They are seashore towns, as is also Falmouth, whose roads were improved in 1905 to 1908. Their valuations in 1900 and 1915 were as follows:—

Bourne	$2,141,000	$ 7,350,000
Yarmouth	1,785,000	2,521,000
Barnstable	4,328,000	9,347,000
Falmouth	7,342,000	16,862,000

Sandwich, which lies between Bourne and Barnstable, only secured a good road connection two years ago, although it is on the seashore and also on a through route. Her valuation in 1900 was $971,000; and in 1915, $1,494,000. This again shows that the towns that are connected up on the seashore that had good roads early, are at least the ones that developed most.

The value of these improved roads is also shown in the fact that in Barnstable county, with fifteen towns in all, the valuation increased from $24,206,000 in 1900, to

Paradise Road, Swampscott, Mass.

$53,138,000 in 1915, an increase of 119½ per cent. Five of these towns in this county that had good roads increased in valuation from $16,150,000 in 1900, to $43,875,000 in 1915, an increase of 171 per cent., or 96 per cent. of the total increase in the county. The remaining ten towns increased in valuation during these fifteen years $1,209,000, an increase of only 4 per cent.

Taking some of the little interior towns on Cape Cod:—

Carver began to improve its roads very early. Its valuation in 1900 was $908,000; in 1915, $2,000,000.

Pembroke also improved its roads. Its valuation in 1900 was $623,000; in 1915, $1,246,000.

Plympton in the immediate neighborhood had no good roads. Its valuation in 1900 was $331,000; in 1915, $464,000.

Western Massachusetts

Going into the western part of the state, among towns that raise apples, milk, etc., Ashfield and Buckland were connected up by a good road prior to 1900.

The valuation of Ashfield in 1895 was $496,000; in 1915, $906,000. This town had a good road to the same railroad station as the adjoining town, Buckland, but had a five-mile longer haul. The valuation of Buckland in 1895 was $550,000; in 1915, $2,000,000.

Conway is a little farming town next to Ashfield; had no good road; not yet connected. Its valuation in 1895 was $681,000; in 1915, $833,000.

Hawley is an adjoining town on the other side, a farming town not connected with a good road. Its valuation in 1900 was $141,000; in 1915, $242,000.

To cite some farming towns in the extreme western part of the state:—

The town of Richmond began to improve its roads many years ago. In 1900 it had a valuation of $326,000; in 1915 the valuation was $621,000; and I am informed that all of this increased valuation came on the land within a half mile of the improved road which runs the length of the town.

Attracts the Summer-Home Builders

A little town in the same county which is not connected with a good road as yet, the town of Savoy, had a valuation in 1900 of $157,000; in 1915, $196,000.

Take another town in the same county, a farming town that is not as yet connected with a good road, Monterey; valuation in 1900, $226,000; in 1915, $385,000.

An illustration of a town in that neighborhood which has improved roads and also is a somewhat fashionable summer resort, is Lenox. Its valuation in 1900 was $3,700,000; in 1915 it was $8,470,000.

It is very noticeable that where we start to build a road through the country in the western part of the state, which is full of wooded hills and brooks, that often before the road is built, but after it is started, the summer people come in and buy up abandoned farms and erect good houses. I have one town in mind where the road will not be built for two years, but since we began five years ago, it has had five such summer residents locate there and build houses, the houses probably averaging in cost from $8,000 to $25,000. Often these new residents run quite large farms.

In some ways there is an even stronger argument for good roads than the increase in land values. A practical one is the actual saving to the farmer; which, however, really increases the actual value of his farm.

I have a letter from a man who owns a large farm in Orillia, near Seattle, Washington. He was thirteen miles from his market, making a haul of twenty-six miles a round trip. He could only pull with a pair of 1,700-lb. horses, 2,500 pounds of cabbages at a load, and it took him 12 hours on the old unimproved roads. An improved road was built, and he now hauls 5,000 pounds and can make the trip in 9 hours.

How the Farmers Save Money

Calling the team worth $5 a day, he saved 30 days in hauling the cabbage crop to market,—75 tons of cabbage. If the team be worth $5 a day, that means a saving of $150 on 75 tons, or $2 a ton; and, of course, he could use his team for the thirty days on some other work.

This man, Frank Terrace, stated that the farmers in his neighborhood produce milk; that the city of Seattle consumes 35,000 gallons of milk and 4,000 gallons of cream a day. There was an average haul to the railroad of 2 miles; they had to deliver the milk at the depot early in the morning; the railroad carried the full can and brought back the empty at one cent a gallon; then the retailers had to collect the cans at the railroad station in Seattle.

Since the new road was built, the farmers put their milk out on the road at their farms, and a truck collects it and delivers it to the distributing station in Seattle, thus saving two handlings; and the truck people only charge a half cent a gallon for the service.

The saving on this milk alone amounts to $195 a day, to say nothing of the saving in time for the farmers, cost of teams, etc. This saving amounts to $71,000 a year.

More Than Pays for Road

If this be compared with the cost of the thirteen miles of road, say, even if the road cost them at to-day's high prices, $20,000 a mile, that would equal $260,000; interest at 4 per cent., $10,400; twenty-year serial, $13,000 a year; or an annual charge, including interest, of $23,400 for a saving of $71,000 to the farmers on the milk alone.

If you figure their savings on cabbages alone at $150 a year, and leave out the thirty days that the teams could be used for something else, that equals a tax rate of $1 per $1,000 on a $150,000 valuation, which would be quite an extensive farm.

In one of our Massachusetts towns that raises apples, they had about an eleven-mile haul to the railroad station. The teamsters tell me that in the old days they hauled apples at fifty cents a barrel. Since the roads have been improved, they are now hauling the apples at twenty-five cents a barrel and are hauling three times as many barrels to the load; so the teamsters are collecting fifty per cent. more money, and the farmer is only paying fifty per cent. of what he formerly paid per barrel. Also on the return load, as the grade has been improved as well as the road, they are hauling three times as much grain or coal back to the town, which happens to be the town of Ashfield that I mentioned above.

I stopped some of the farmers about ten miles out from the city of Detroit, in Wayne County, Michigan, and asked them what the concrete road built there had done for them. They differed. Two told me that they hauled three loads a day over an ordinary country road in bad weather, and that when the road was improved they loaded what would equal the three loads onto one load, and carried it into town with much greater ease for the horses than when they had only one-third of the load. Five or six others said about the same, only that they hauled two loads to the one load.

Road Brings Twenty-six New Houses

In many parts of Massachusetts, we are now hauling an average of three tons to a load, with two horses, where before the road was improved they could only haul three-quarters of a ton. This is in the sandy section of the state. On the ordinary dirt road, the amount that can be hauled has more than doubled; and where grades are improved as well as the road, the amount has trebled.

In France they consider three tons as a one-horse load. In order to enable horses to pull three tons they had no grades on the main roads exceeding five per cent. They always figured formerly that it cost eight cents per ton per mile to haul farm products. We figure in this country that it costs twenty-five cents per ton per mile over an ordinary road.

I might add also that on one stretch of road, 1½ miles long, just completed last fall in Arlington, there have already been three streets opened up connecting with it; farming land has been cut into building lots; and twenty-six houses, costing from $2,500 to $4,000 each, were constructed before the road was completed.

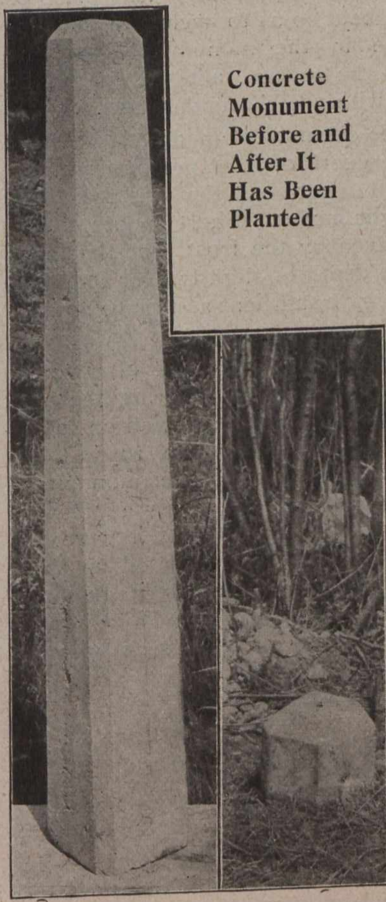
On a road that we built in Gloucester, a mile long, 28 houses out of the 38 were repainted, four new piazzas were added, and a number of improvements like fences, etc., were built, greatly improving at any rate the appearance of the locality.

HIGHWAY SURVEY MONUMENTS

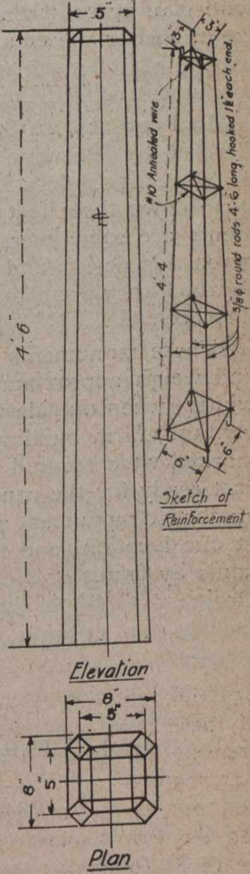
By Geo. Hogarth
Engineer of Highways, Province of Ontario

IT is necessary on provincial highways that the limits of the road allowance should be monumented in an easily interpreted manner, in order that the companies and people interested in the highway may know or may be able to ascertain readily the lines marking the sides of the road. Such monumenting is a convenience to the people. When new fences and buildings are constructed, it is then a simple matter to identify the boundary of the land fronting on the highway, and the fence can be built accordingly.

Encroachments on highways by fences and buildings are not unusual and in many places the actual width of the



Concrete Monument Before and After It Has Been Planted



road between fences is frequently less than the registered width. To provide for the different public services, such as power, telephone and telegraph lines, requires that every foot of width be used to advantage, so that the delimiting and monumenting of the road is an important matter.

Monuments suitable for such work should be permanent so far as possible; they should be indestructible and of such a size as to discourage their easy removal. They should also have a composition which would not prove tempting to souvenir hunters.

Evidently wood is an entirely unsuitable material as it is not permanent and is liable to easy destruction or removal. A metal post was considered by the Department of Public Highways of Ontario, and the excellent monuments of the Dominion Lands Survey were carefully examined and the costs enquired into. Metal posts used by other Dominion and municipal departments and commissions were also examined. The experience with metal posts in a settled community is that the metal proves tempting and the posts or caps do not remain in the original position very long.

Concrete survey monuments have been used with success in southern Ontario for some time and several satisfactory designs are in existence. After careful search of all existing information on such monuments, the design shown in the accompanying drawing was prepared. The length of this monument is 4½ feet, with the base 8 inches square and top 5 inches square, giving a taper of 1½ inches to the sides, with a 1-inch chamfer at each corner. Steel reinforcing bars are placed in the corners of the monument, the bars being ⅜-in. round, with the ends hooked. To prevent splitting of the concrete, the bars are wound at four places with No. 10 annealed steel wire. A centre point is provided by placing a piece of No. 10 copper wire in the top of the monument. This piece of wire is 6 inches long and bent so as to anchor to the concrete. After the concrete in the monument is set, the wire is cut off flush with the surface, and the top of the monument rubbed down with a carborundum stone.

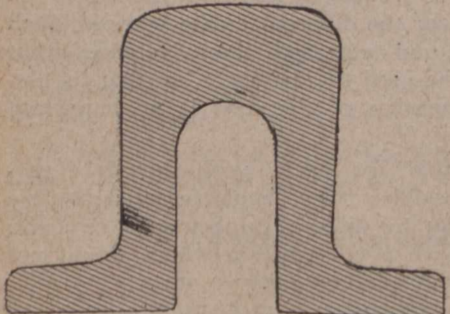
In February, 1918, the department made tests east of Toronto to determine the depth of frost penetration, and in one exposed location it was found that the frost had gone down three feet eight inches. Short square monuments are sometimes heaved by the frost, but the taper given this design and the depth of slightly over four feet to which they are planted, give sufficient assurance against displacement.

These monuments contain 1⅓ cubic feet of concrete and weigh approximately 200 pounds. During the past winter, when outside work could not be carried on to advantage, farm buildings convenient to the roads to be marked were secured and a number of the monuments cast ready for the construction season. Only a sufficient number to monument a road across one township were cast at one location, and they are being distributed on short hauls by teams or steam tractors as occasion requires. Ordinary post-hole digging tools have been found satisfactory for opening an excavation of the proper dimensions.

LETTER TO THE EDITOR

Old Grand Trunk Rail

Sir,—Enclosed please find section of Grand Trunk Railway 1856 rail, which may be of interest. We received a short piece of this recently for the Waterloo Historical Society, which is accumulating something of a transportation museum. Our specimen is considerably rust-pitted. It weighs, as it is, about 59 lbs. per yard; probably the original weight was 60 lbs. per yard. You will note that the base is not quite a plane and that the top surface shows apparent slight wear.



W. H. BREITHAUPT, C.E.

Kitchener, Ont., June 3rd, 1918.

SOME ASPECTS OF CHEMICAL TREATMENT AT ST. LOUIS WATERWORKS*

By A. V. Graf,
Chief Chemist, St. Louis Waterworks

THE principal streams contributing to the water supply of the city of St. Louis are the Mississippi, Illinois and Missouri Rivers. The Illinois River enters the Mississippi thirty-three miles north of the intakes at the Chain of Rocks, and in traversing this distance a more or less intimate mixture of the two waters is effected. The Missouri River enters the Mississippi five and a half miles north of the intakes, and causes a pressing of the Mississippi River water upon the east bank of the river, and in this way, as a rule, very little mixing of the two waters occurs by the time the water reaches our intakes. At times the turbidity of the water on the west side of the river is ten times as great as that of the water on the east side, and at other times the color of the east water is 25 parts per million greater than that of the west water, showing the incompleteness of the mixing of the two waters. With a high stage in either river and a low stage in the other, the mixing of the waters is more complete.

Mississippi, Missouri and Illinois Rivers

The waters in each of these rivers have certain characteristics which become of greater or less interest as the stages of the rivers vary. The Mississippi River drainage area being covered with swamps, the water in this river becomes highly colored at times of heavy run-off, while the Illinois River, carrying a large amount of sewage, contains colloidal organic matter, which seems to act as a protective colloid on the turbidity carried by this river. The water in the Missouri River, always turbid, becomes much more so at times of heavy run-off. The dissolved solids in these waters vary considerably, but dissolved solids offer no difficulty in the treatment of the water, and are, therefore, of less interest.

The river water enters our plant through two intakes, one, the old, or west, intake, 1,500 feet east of the west bank of the river, and connected to the wet well by a 7-foot circular, brick-lined tunnel, 2,197 feet long. The other, or east intake, is 700 feet east and 200 feet north of the west intake, and is connected to the wet well by an 8-foot circular, concrete-lined tunnel, 2,747 feet long.

The water drawn through the west intake is principally Missouri River water for the greater part of the year, while the water drawn through the east intake is that of the mixture of the Mississippi and Illinois River waters, although at times the water at both intakes is practically the same, both chemically and physically.

150,000,000 Gallons a Day

The east intake was in service only ninety-seven days during the past year, whereas the west intake was used for three hundred and fifty days. Because of the greater difficulty of treating the water from the east intake, this is not used unless low stages of the river or anchor ice, or both, are affecting the pumping.

The water entering the tunnels flows by gravity to the wet well, whence it is pumped, against a dynamic head of 58.3 feet, into the delivery well, and flows from there to the grit chamber, where the average velocity of flow, at a rate of pumping of 150,000,000 gallons per

*One of a series of four papers on St. Louis Waterworks presented before the convention of the American Waterworks Association, held recently in that city.

day, is only 0.33 foot per second. In this chamber the coarser and heavier part of the suspended matter is deposited, the amount removed depending upon the character of the suspended matter, as well as upon the amount present in the water. The efficiency of the grit chamber is shown in the fineness of the material removed, over 50 per cent. of the matter deposited passing a 100-mesh sieve. The tons of matter removed by the grit chamber during the past year was 63,703, or 23 per cent. of the total suspended matter present in the water.

Chemicals Pumped to Mixing Chamber

Leaving the grit chamber, the water flows through a short conduit to the mixing chamber, where milk of lime and a solution of sulphate of iron are added. These chemicals are prepared in the coagulent house for addition to the water, and are pumped a distance of 900 feet to the mixing chamber.

The lime is weighed out in automatic scales, and is dumped into circular slaking tanks, which are provided with revolving rakes. The temperature of the milk of lime in the slaking tank is kept at 200° F. This is accomplished by keeping up the temperature of the fresh water supply by passing it through the coils of a heater tank into which the milk of lime at 200° is drawn. From 4 to 4½ pounds of water per pound of lime are used in slaking. The water overflowing from the water tank is run into a cooling and diluting box, where the temperature is reduced to as low as 64° in winter time to 108° in summer. The strength of the milk of lime as pumped is 38,600 parts per million of CaO.

A slaker tank is kept in service until the accumulated unslakeable material is great enough to impede the motion of the rakes. From 50 to 150 tons of lime are slaked before a tank is taken out of service, the amount depending upon the purity of the lime. Tests made to determine the effect of limes of varying percentages of CaO upon the amount of lime that could be slaked before a slaking tank had to be taken out of service showed that for every increase of 1 per cent. in the available CaO, above the lowest lime tested, an additional 10 tons could be slaked. Contracts for lime are let under a specification requiring a lime of 85 per cent. CaO, with a bonus or penalty of 1.5 per cent. for each 1 per cent. above or below the required 85 per cent.

The Mixing Conduit

The sulphate of iron is measured by passing it through an adjustable orifice on to the surface of a cylindrical drum, revolving at a constant speed, and is discharged in a continuous flow into a tank, where it is dissolved without stirring by water entering through a manifold at the bottom of the tank, the solution being drawn off through an overflow.

The mixing conduit, into which the chemicals are delivered, is a reinforced concrete box, 2,382 feet long, 32 feet 1 inch wide and 12 feet 6 inches high, divided longitudinally into four compartments, each 7 feet wide and 11 feet high. The four compartments are supplied with stop-plank openings so that they may be thrown in parallel, used in series or withdrawn from service for cleaning. In normal operation the water enters the west channel and travels the full length four times, a total of 9,528 feet, having an average velocity of 3.3 feet per second when the rate of pumping is 150,000,000 gallons a day.

Provision is made so that the lime or iron may be added to either of the four compartments, but the lime is added, for the greater part of the time, to the raw water as it enters the mixing conduit and the sulphate of iron as it leaves the conduit. The period of mixing averages about one hour. The sides and bottoms of the first two compartments are bady coated; the coating on the sides is practically all calcium and magnesium carbonate, and magnesium hydroxide while the bottom coating consists of the sand and unslakeable material present in the lime added bound together by the precipitated calcium carbonate and magnesium hydroxide.

The value of the mixing chamber is shown by an occurrence of last year. A leak in the south end of the mixing conduit, due to the failure of the contractor to properly plug a drain, caused the conduit to be taken out of service. The water was passed from the delivery well direct to the first of the sedimentation basins the sulphate of iron being added in the tunnel at the coagulent house and the milk of lime at the delivery well.

Value of the Mixing Chamber

The turbidity of the water in the delivery well was 2,500 at the time and the turbidity of the water in the last of the sedimentation basins was 20, the amounts of chemicals added being 6.25 grains of lime per gallon and 0.25 grain of sulphate of iron. After the mixing conduit was taken out of service, the sulphate of iron was increased to 2.50 grains per gallon, the lime remaining the same. In forty hours the turbidity of the water, in the last of the sedimentation basins, increased to 40, the turbidity of the river water remaining practically the same as on the preceding days. By adding ten times the amount of sulphate, the results were still inferior to what was accomplished with the mixing conduit in use. The additional cost due to the use of a larger amount of sulphate of iron while the conduit was out of service, one and one-half days, was $390.

The points of application of the milk of lime and sulphate of iron depend upon the condition of the raw water. With a water high in color and low in turbidity the iron is added before the lime with good results. If the high color is accompanied by a turbidity of 200 to 300 parts per million, better results are obtained by adding the sulphate of iron as the water leaves the mixing conduit. With high turbidity the lime is always added at the first opening and the sulphate of iron at the last. With low color and low turbidity due to colloidal matter, the sulphate of iron is added at the third opening, which allows a mixing through one-half of the conduit. At times, with finely divided suspended matter in our raw water, the only sedimentation that takes place is accomplished in the first basin, the turbidity of the water in the last of the sedimentation basins being as great as that of the water leaving the first basin.

Color is Increased Sometimes

With high stages in the Mississippi and Illinois Rivers and a low stage in the Missouri, we encounter our worst condition. The high color of the Mississippi, together with the colloidal matter in the Illinois, make a water hard to handle. The use of sulphate of iron as a coagulant at these times is accompanied by some difficulty. The coloring matter of the water combines with the iron, and instead of a diminution in color, the color is increased. The suspended matter being really colloidal and some of the iron hydroxide remaining in the colloidal condition, the turbidity of the water after sedimentation is greater than that of the river. This highly-colored and turbid water is much less amenable to treatment with sulphate of alumina. The amount of sulphate of alumina required to give the required flocculation of the suspended matter is from 4 to 5 grains per gallon. With this large amount of sulphate, the water passing the filters is clear but is still of high color, the iron content being eight to ten times as great as normally. At times, when this condition occurs, no relief is experienced until the Missouri River run-off increases, and thereby gives us a turbid water which offers enough suspended matter for the rapid subsidence of the floc of ferric hydroxide. The more turbid the water at our intakes, the less trouble we have with turbidity causing material remaining in suspension.

Operation Record for Year Ending February 28th, 1918

Chain of Rocks.

		Basins out of service	Days out of service	Remarks
Water pumped (Chain of Rocks) in million gallons	39,289.23			
Water consumed in million gallons	38,024.64	No. 1	24	Basins cleaned:
Water filtered	39,351.70	No. 2	24	No. 1 May, July, November, mud 128 inches
Water used in filter house operation	805.22	No. 5	11	
				No. 2, May, July, mud 87 inches.
Water used in coagulant house operation	97.95	No. 6	14	No. 6, November, mud 45 inches
Water used in basin operation (filtered)	278.49	No. 8	123	No. 9, August, mud 46 inches.
Water used in basin operation (unfiltered)	593.04	No. 9	9	
Water used in purification. Total	1,774.70			

Chemicals used

Description	Pounds	Grains per gallon		
		Maximum	Minimum	Average
Lime	30,147,933	8.00	4.00	5.371
Sulphate of iron	4,294,689	2.50	0.00	0.765
Sulphate of alumina (meters)	3,781,163	3.68	0.11	0.673
Sulphate of alumina (influent)	29,560	0.25	0.00	0.005
Sulphate of alumina (filters)	108,756	14 pounds per wash	0 pounds per wash	0.019 grains per gallon
Chlorine	74,516	4 pounds per million gallons	0 pounds per million gallons	1.89 pounds per million gallons

Variations in water

Description	River water			Settled water			Applied water			Water to hs. pumps		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
Stage of river	105	74.9	78.4									
Temperature	84	32	54									
Turbidity, parts per million	5.000	8	1,240	110	9	24	32	4	10	0	0	0
Color, parts per million	48	10	22	35	6	14	32	5	12	28	4	9
Suspended solids, parts per million	6,930	6	1,700							0	0	0
Dissolved solids, parts per million	468	190	310							370	150	215
Total solids, parts per million	7,210	400	2,010							370	150	215
Alkalinity total, parts per million	233	93	145	146	32	60	136	27	56	127	26	53
Alkalinity caustic, parts per million				8								
Alkalinity bicarbonate, parts per million	233	93	145	122		20	120	0	28	115	8	29
Hardness total, parts per million	304	116	193							188	66	108
Bacteria gelatine, per cubic centimeter	625,000	600	55,500	7,000	59	1.020	4.800	53	710	530	2	98
Bacteria agar, per cubic centimeter	27,000	110	7,300	450	15	97	290	9	57	57	2	11
Coli, per cubic centimeter	80	0.2	17.2			0.259			0.271			0.0106

Number filters in service ... 40	Run of filter in hours: Max. 206.75; Min. 6.92; Av. 50.2	Bacteria agar effluent ... 16
Number filtering hours ... 343,743	Run of filter in million gallons: Max. 22.63; min. 0.876; Av. 5..67	Bacteria gelatine effluent ... 185
Average rate filtration, million grains daily ... 85.39	B. coli per cubic centimeter in effluent ... 0.0485	
Rate of wash, gallons per million ... 21,000	B. coli p:r cubic centimeter tap water average ... 0.0121	
Number of washes ... 8.931	Bacteria agar. Tap water average...10	
Per cent wash water used ... 1.56		
Average gallons used per wash ... 78.990		

After passing through the mixing conduit, the water enters the first of six sedimentation basins, each 400 feet long by 670 feet wide, of 30,000,000 gallons capacity. The first three division walls have five stop-plank openings and the last two four openings, all 4½ feet deep by 8 feet long. These openings render the sedimentation basins less efficient than would wiers extending the full width of the basins, but because of the necessity of maintaining an elevation of the water but little lower than the top of the basins, the need of stop-plank openings at times of cleaning is apparent. The time of sedimentation, based upon the capacity of the basins, varies from thirty to forty-three hours, but the actual time is much less, the effects of a change in the amounts of chemicals added being noticeable in twelve to fifteen hours in the last of the basins. About 90 per cent. of the suspended matter and bacteria are removed in the first basin and 9 per cent. in the remaining basins.

The total amount of matter removed from the water during the past year, including the chemicals added and the dissolved solids removed, amounted to 326,775 tons, or 484,111 cubic yards. Some of the mud was removed by opening the sewer-gate for one-half hour at varying intervals, but the greater part was removed from the basins by labor and teams. The teams are used to draw scrapers, which cut off portions of the mass of mud and drag them to the central gutter, through which water is flowing. The men are provided with scrapers, which are used as such, and also as braces to keep small A-shaped boxes in place, as the mud drawn by the horses and the water used to aid in removing the mud are drawn by the boxes. The cost of the removal of the mud from the sedimentation basins, not including the cost of the water, was 0.762 cent per cubic yard for the past year.

The water leaving the sedimentation basins enters a collecting conduit and passes through two 8-foot Venturi meters and into a small secondary coagulation basin, connected to secondary sedimentation basins by stop-plank openings. The solution of sulphate of alumina is added at the throat of the meters, and is automatically controlled so that the quantity added per unit is constant for any setting, regardless of fluctuations in the flow through the meters.

No mixing chamber is provided here because of the low permissible loss of head, namely, 1½ feet. There are two secondary sedimentation basins, one east of the filter plant and one north, each of which is connected to the influent flume of the filters. The time of reaction and sedimentation, based on capacity, is twelve hours with both basins in service and six hours with one. The water entering the secondary coagulation basins being usually of a turbidity less than 20, little sedimentation takes place. It is not expected that these basins will need cleaning for some years.

The water entering the filter plant is passed through 40 filters, each with a filtering area of 1,400 square feet, of 4,000,000 gallons capacity. The filtering media consist of 30 inches of sand above 12 inches of graded gravel. The effective size of the filter sand as placed in the filters was 0.341 mm., with a uniformity coefficient of 1.81. The effective size has increased to 0.407 mm. and the uniformity coefficient has been reduced to 1.45, due to the coating of the sand grains by material having the following composition:—

	Per cent.
$CaCO_3$	76.00
Al_2 $(YH)_3$ and FE $(OH)_3$	15.00
Mg $(OH)_2$	9.00

Liquid chlorine, in the form of chlorine water, is added after filtration in a chamber in which the filtered water from the three connections to the effluent flume is combined. Two conduits, one a 7-foot ½-inch steel tube, the other a brick and masonry conduit 9 feet high and

11 feet wide, are connected to this chamber. These conduits convey the water to the pumping stations at Bissell's Point and Baden. The bacterial reductions caused by the chlorine were far from satisfactory until a baffle was built in the chamber to aid in mixing the chlorine with the water.

The reduction in bacteria in the water flowing through the steel line is always less than in the water in the brick conduit. Charges of chlorine great enough to give tests for free chlorine in the water in the brick conduit three hours after treatment give no test in the steel line three minutes after. The disappearance and ineffectiveness of the chlorine in the water entering the steel line is attributed to the steel of the line. The Electro Bleaching Gas Company supplies the liquid chlorine, which is measured and controlled by the liquid type meter apparatus, also supplied by this company.

The accompanying operation record for the year ending February 28th, 1918, shows very clearly the kind of water treated, the improvement in the condition of the water for each step of the purification system, the amounts of chemicals used and other details of operation.

WATER WASTE*

By Edward E. Wall
Water Commissioner, St. Louis, Mo.

At this time, when the necessity and the demand for the conservation of all materials and supplies is universal, the presentation of some facts in regard to the waste of water, its value and the wisdom of restrictive measures should be of interest. The normal mind is opposed to the existence and the continuance of waste—and yet, on consideration, no thoughtful man would advocate the absolute elimination of waste. Our whole social and economic system operates with the expectancy of loss from waste, and a large percentage of our activities are devoted to making provision for meeting such losses.

The province of the engineer is pre-eminently the prevention and reduction of waste. He is now, and always has been, continuously striving to prevent loss of energy, and to reduce the waste of materials and labor.

The waste entailed by progress, such as the consignment to the scrap-heap of machinery not worn out, but obsolete,—the wrecking of a perfectly good building in order that upon its site may be erected something better and more useful to mankind,—or the discarding of any useful thing for something more useful, may all be classified as instances of necessary and proper waste. So also may be justified a reasonable amount of waste of time, energy and materials in the pursuits of pleasure and the extravagances of living in general.

The engineer, too, wastes much time and labor on problems that either are unsolvable, or his solutions are presented at untimely moments. Thousands upon thousands of engineers' reports are placed on shelves, never opened; their existence forgotten, although many of them represent thorough and painstaking labor covering periods of many months, and are full of elaborate details pertinent to the case. This sort of waste is, perhaps, largely unavoidable and incidental to the development of the general resources of our country,—and may also be necessary for the education of the engineer.

*Abstracted from paper read before the Engineers' Club of St. Louis.

It may also happen under some conditions that what appears to be waste may be economy: for example, when the Nebraska farmers used corn for fuel because taken for its heat value it was cheaper than coal,—or in those cases where the expense of saving or reclaiming anything of value is more than the value of the thing reclaimed.

The illogical insistence of the people of St. Louis on clinging to a policy requiring the unlimited and unrestricted use of water at a flat rate, together with the heedless disregard of all warnings and protests from Water Department officials, has, many times, taxed the resources and capacity of the waterworks to its utmost limit,—and on a few occasions has brought the city to the verge of a water famine.

From 6 to 212 Gallons

The writer, in May, 1912, measured the consumption in 37 residences containing 212 occupants, finding an average per capita per day of 57 gallons, with a daily minimum of 7, and a maximum of 202 gallons. The same 37 houses in June, 1912, showed an average daily per capita consumption of 54 gallons, minimum 6, and maximum 212 gallons. Average daily consumption for May, 1912, 83.5 m.g.; average daily consumption for June, 1912, 85.5 m.g.

Taking the results of measurements taken in St. Louis, together with reports from observers in other cities, the average quantity of 40 gallons per capita per day would give an ample supply for domestic use.

The quantity of water daily used for public purposes, such as street washing and sprinkling, in public buildings and parks,—and for extinguishing fires, as nearly as can be estimated, should not exceed 12 gallons per capita.

The daily commercial use of water in various cities ranges from 30 to 60 gallons per capita, so that it is safe to estimate 45 gallons as sufficient, while the unavoidable losses of water from the system, such as undiscoverable underground leaks, losses from draining mains for repairs, from leaks and breaks before they can be shut off, from the slip of meters, and water stolen through unrecorded connections and deliberate misrepresentations, will be covered by an allowance of a daily per capita of ten gallons.

A daily consumption of 107 gallons per capita as above divided between domestic, public and commercial uses, including the allowance for unpreventable losses, will not only provide an ample supply for all legitimate uses,—but will still admit of extravagance or waste to a considerable extent, perhaps 20 per cent.

Wanton Waste

The actual average daily per capita consumption for the calendar year 1917 was 133 gallons. This excess of 26 gallons per capita per day represents the actual wanton waste for which there is no justification whatever.

It means that 20,000,000 gallons of water were daily pumped into the mains and deliberately wasted into the sewers and drains without having served any useful purpose. The cost of pumping, purifying and re-pumping this water was not less than $40 per million gallons for operating and maintenance charges alone, or a total value of $800 per day absolutely thrown away, amounting to the total sum of $292,000 for the year 1917.

An examination of the records of the daily consumption for 1917 reveals the fact that water waste is not systematic or uniform, but spasmodic, and erratic, largely fluctuating with the weather. The months of greatest consumption during the summer were June, July, August and September, and in the winter season, February and December.

The days of the heaviest consumptions were those of the highest temperatures in summer, and the lowest in winter.

The rapidly increasing consumption during the last few days of December, 1917, as the temperature gradually lowered, was but the beginning of the period of the longest and heaviest demand ever made on the waterworks. From December 28th to February 8th inclusive, a period of 43 days, the minimum consumption (one day excepted) was 110,600,000, and the maximum, 156,500,000 gallons.

The daily average for the 43 days was 126,400,000 gallons.

It must be remembered that no water could be used during this time for street sprinkling or washing, so that the normal use of water would have been no more than during moderately cold weather in November or March, when the consumption averaged about 92,000,000 gallons. The difference between 92,000,000 and 126,400,000 would represent what may be called the super-waste of water during that period of 43 days, amounting almost to $60,000 at the rate of $40 per million gallons.

10,000,000 Gallons Wasted

The use of 92,000,000 gallons daily under moderate weather conditions is about 120 gallons per capita, meaning that at least 10,000,000 gallons is normally wasted during the periods of most favorable weather, and super-waste occurs at all other times.

The coal burned per million gallons of water pumped by actual weights taken in the boiler rooms averaged 2,800 lbs. This means that over 65 tons of coal were consumed each day for 43 days in pumping water that was allowed to run to waste into the drains and sewers.

This 2,800 tons of coal was consumed at a time when the United States Fuel Administrator was urging economy and restricting coal deliveries to the bare necessities of preferred classes of consumers.

Criminal waste is essentially a vice of civilization. The barbarian may ignorantly or thoughtlessly allow valuable materials to go to waste because of an abundance over and above his uses at the time, or through an inability on his part to foresee his future needs,—but he cannot be accused of knowingly and intentionally destroying things of value to himself, except as war measures to inflict injury on the enemy.

It takes the astute civilized man to deliberately injure his own tribe by consigning car loads of food products to the dump in order that the available supply may be restricted and local prices kept up.

It is the twentieth century civilization that mortgages the future and cheerfully bequeaths the debt to later generations.

House-to-House Inspection

The method of house-to-house inspection for eliminating leaks and waste depends for its efficiency on the frequency of individual inspections,—but it can never be completely effective. It is not in human nature for inspectors to continually perform duties more or less unpleasant,—and to perpetually make visits that are usually unwelcome, yet all the time maintain a high standard of efficiency. It does not generally require many months for an inspector to become somewhat weary of going over the same ground,—to relax his vigilance and to make his visits somewhat perfunctory. We could hardly expect to find, as a rule, for the positions of inspectors at salaries of $75 per month each, men with a keen sense of humor, who would so enjoy the experience of coming in daily contact with many various and sundry specimens of humanity, that the employment would become a pleasure. People do not like to have their houses inspected. In general, they feel that in paying for a water license, they have certainly purchased a right to an extravagant use of water,—if not an absolute privilege to waste it if they desire to do so. In summer they waste many times more water in lawn-sprinkling than is necessary for the growth of the grass and flowers. In extremely cold weather they let the water run to prevent pipes from freezing. No doubt it is more economical for the consumer to waste water than to pay plumber's bills, so long as his premises are assessed at flat rates. The claim may also be set up that the loss to the community, as a whole, would be less from the general wasting of water, than the total expense of repairing all the bursted piping that would result if the water was not allowed to run and wholesale freezing resulted. This claim might be substantiated if the matter ended with the mere comparison of the value of the water wasted and the probable plumbers' bills. Unfortunately the value of the water lost is but a small part of the damage done to the public.

The demoralizing effect of approving waste under certain conditions should be readily apparent, and its consequences could not help but be of additional assistance in forwarding the day on which the water supply would be unequal to the demand.

The owner of a building improperly piped for water, with no adequate facilities for draining the system, may feel that he is not justified financially in removing the old plumbing and installing a new and proper system; he may argue that he is confronted by a condition for which he should not be held responsible; that he is an innocent purchaser of a building erected years ago, presumably in conformity with all building regulations in force at the time; that he would be able to collect no more revenue from his building after reconstructing the plumbing than before; granting that all of his premises are true, he still cannot escape the fact that in protecting his individual interest by wasting water to avoid plumbers' bills, he is trespassing on the rights of his fellows,—and is helping to impose increased taxation on the people of the whole city.

Meters Are Effective

His case would be but little better if his premises were under meter and he was paying for the water wasted, since the indictment against him for sinning against the welfare of the community would still hold. In all probability, if he was paying for the water at meter rates, little or no water would be allowed to run to protect the plumbing.

The only effective and economical method of reducing water waste and leakage to a minimum is through the general installation of meters.

The results attained will be permanent, and the meter will automatically act as an inspector perpetually on the job.

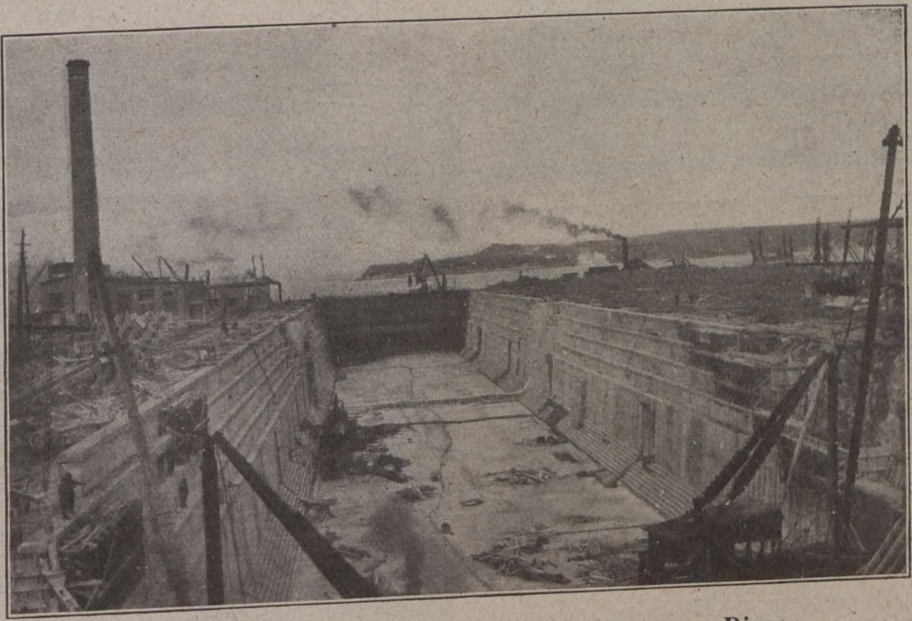
Hon. Frank Cochrane, minister without portfolio in the Union Government, and ex-Minister of Railways and Canals, while in Toronto this week stated that in his opinion the head offices of the Canadian Northern Railway will not be moved from Toronto.

The "Toronto Daily Star" says editorially:—"That the Canadian Northern head office should remain in Toronto under government ownership is not merely a matter of local pride. Toronto is the home of friends of public ownership. Montreal is the home of its enemies. It was from Montreal that a protest was sent to the government against government ownership of the Canadian Northern Railway. The sentiments of Montreal ought to be respected, not insulted by the presence of the headquarters of the government system."

CHAMPLAIN DRY DOCK, QUEBEC*

By Ulric Valiquet, M.Can.Soc.C.E.
Supervising Engineer, Department of Public Works, Ottawa

FOR a number of years the River St. Lawrence has been frequented by ocean steamers of such dimensions that they could not be accommodated in the Lorne dry dock, completed in 1886, at Lauzon, in Quebec harbor. In 1906 the Canadian Pacific Railway brought out its steamships "Empress of Britain" and "Empress of Ireland," of 65-ft. beam. The Allan Line steamships "Virginian" and "Victorian" of 60-ft. beam were also placed on the St. Lawrence route in that year. The "Bavarian" of somewhat narrower beam, 59¼-ft., came to Quebec in 1905; thereafter the number of large ships placed on the St. Lawrence traffic increased rapidly, until in 1912 there were 25 vessels that could not have been repaired in the long stretch of the St. Lawrence navigation for want of sufficient dock accommodation, the width of entrance of the present dry dock being only 62 ft. Any of these vessels that required docking had to be repaired temporarily, as well as possible, while afloat, and taken either to Halifax or New York, which, in some cases, was a risky undertaking. The case of the s.s. "Bavarian" was an unfortunate experience in this respect. On November 5th, 1905, she ran aground with a full cargo from Montreal and Quebec, about 40 miles below Quebec, opposite Grosse Isle. Although late in the autumn, she could have been raised and brought to Quebec had there been dock accommodation for her. Her beam was 59¼ ft., but through the accident her sides had bulged out beyond the width of the dry dock entrance. She was raised in the following spring, although further damaged by ice during the winter, and brought on the beach a short distance below the dry dock, where she was sold as scrap. This is the worst case on record in the history of the St. Lawrence navigation. The vessel was only six years old and of a registered tonnage of 10,387 tons.



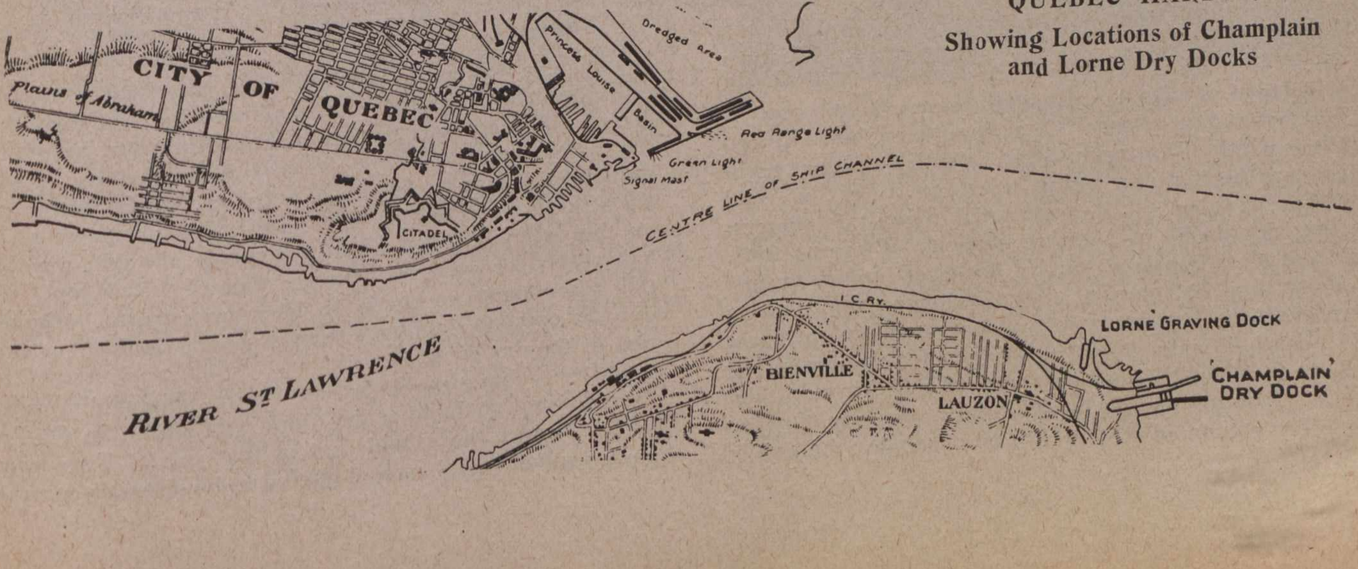
View of Dock, Looking Toward the St. Lawrence River

In the summer of 1898 the writer was instructed to prepare a report on the practicability of widening the entrance of the Lorne dry dock at Levis, which had been completed in 1886. A plan was submitted, showing the possibility of obtaining an entrance 70 ft. wide, by removing part of the timber sides at the outer end of the dock; increasing the length was also suggested. The first was reported to be inadvisable, as it would greatly disfigure the dock and do away with the convenience of the timber slides; the only feasible way would be to remove and rebuild in another position the eastern side wall, thus depriving the harbor of all dock accommodation for probably two seasons. A new caisson would necessarily have to be provided; the cost would have been considerable. Further, it was considered that a new dry dock would be required in Quebec before many years. The suggestion of lengthening the dock was adopted; the length was increased from 484 to 600 ft.; this consisted merely in moving the circular head, stairways and timber slides 116 ft. further, after excavating the rock to proper width and depth. The work was performed under contract awarded in 1900, for $100,000, and completed in 1901 without interfering with the use of the dock. This dry dock was built by the Quebec Harbor Commissioners under an act, 38 Vict. Cap. 56-1875, by which the issue of

*Paper read before the Montreal and Ottawa branches, Canadian Society of Civil Engineers, April 25th, 1918.

QUEBEC HARBOR

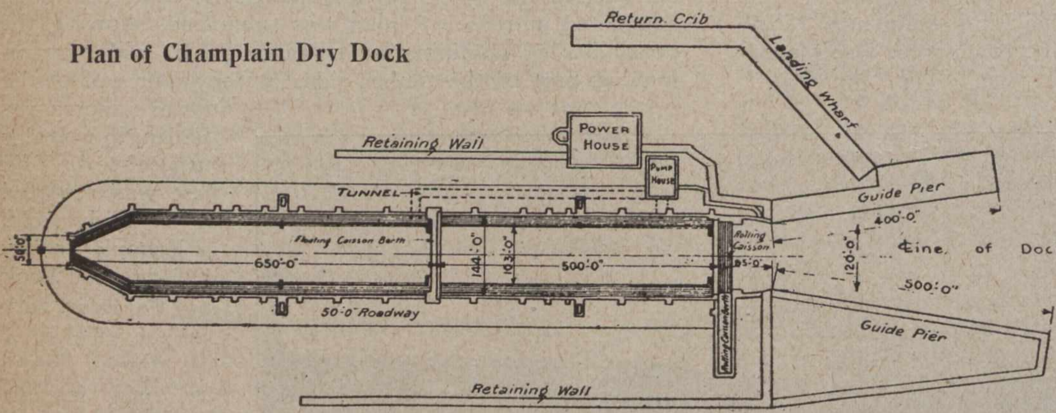
Showing Locations of Champlain and Lorne Dry Docks



bonds was allowed to obtain the necessary amount. The work was started in 1878 and completed in 1886 at a total cost of $921,130. In 1888 the Canadian Government relieved the Quebec Harbor Commission of all obligations to refund the sum expended on the dry dock and in 1890 it was placed upon the control of the Department of Public Works; the writer was then placed in charge.

In 1906 the Quebec Harbor Commissioners urged upon the government the necessity for a large dry dock for Quebec harbor. In the autumn of that year the writer was instructed to make a survey of the locality surrounding the old dry dock and report on the best location. Two sites were examined, but the position to the east of the present dock was considered the most advantageous for three principal reasons. A larger area of land could be acquired. A better foundation could be obtained. The repairing plant of G. T. Davie & Sons could have better access to both the new and old docks. A plan and report were submitted in the early part of 1907; the dock then proposed was 1,000 ft. long with an entrance width of 100 ft. The proposition was not immediately acted upon; the question as to whether the government should build the dock or induce some shipbuilding firm to build it under a subsidy from the government was unsettled. The result of the discussion was the passing at the session of 1910 of an Act to encourage the Construction of Dry Docks.

Plan of Champlain Dry Dock



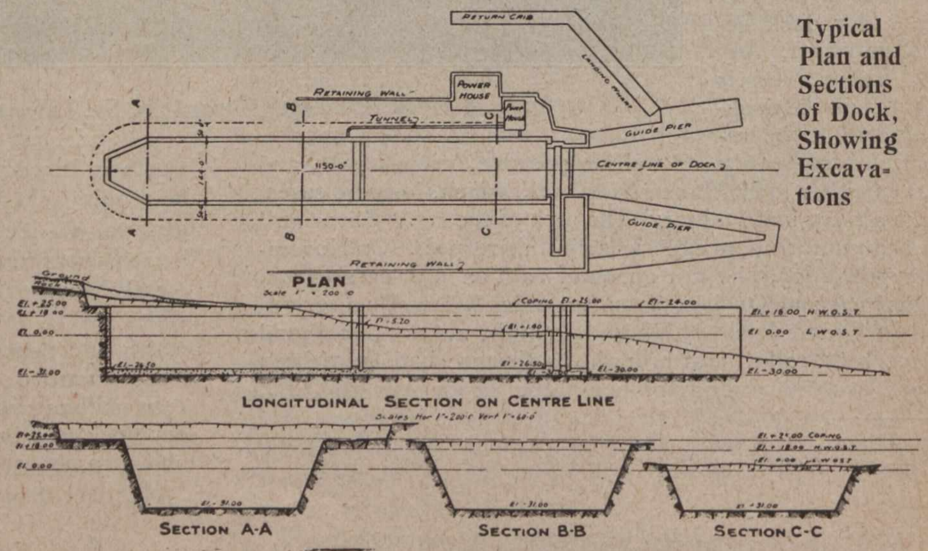
Under this act dry docks were divided into three classes. The first class included dry docks estimated to cost not more than $4,000,000, and capable of receiving and repairing the largest ships of the British navy and of the following dimensions: Clear length on bottom, 900 ft.; clear width of entrance, 100 ft., with depth on sill at high water ordinary spring tides of 35 ft. Floating dry docks of a lifting capacity of 25,000 tons. The second class included dry docks estimated to cost $2,500,000, of the following dimensions: Clear length on bottom, 650 ft.; clear width of entrance, 85 ft.; depth of water on sill at ordinary high water spring tides, 30 ft., if in tidal waters; or 25 ft. on sill, if constructed in non-tidal waters. Floating dry docks of a lifting capacity of 15,000 tons. The third class consisted of dry docks estimated to cost not more than $1,500,000, of the following dimensions: Clear length on bottom, 400 ft.; clear width of entrance, 65 ft.; depth of water on sill at ordinary high water spring tides, 22 ft., if in tidal waters; and 18 ft., if in non-tidal waters. Floating dry docks of a lifting capacity of 3,500 tons. The estimated cost in all cases includes the totally equipped repairing plant, capable of effecting all sorts of repairs, including machine shops and tools, foundry, administration buildings, etc., together with the dock itself, but does not include marine slips or other installation used in the construction of ships.

According to the act, the subsidy on dry docks of the first class is 3½% per annum on the estimated cost for 35 years from the time it has been reported that the dry dock is entirely completed. The subsidy on the second class is 3½% per annum for 25 years from the time of completion. On the third class, the subsidy is 3% for not exceeding 20 years from the time of completion. In all cases the company making the application must furnish plans, with a detailed list of the plant and a complete estimate of the cost. These are revised and corrected, if found advisable; and, upon a report from the chief engineer of the Public Works Department that the works intended to be built are in the public interest, the application is granted upon certain conditions of management and maintenance. The works are to be executed under the superintendence of an officer of the department.

The above act was amended in April, 1912, by making the length of the first class dry docks 1,150 ft., the entrance 110 ft. and the estimated cost $5,500,000. Another amendment was made in May, 1914, by which a subsidy of 4% on the estimated cost is allowed for first class dry docks. The act was further amended in 1917, by which the dimensions of the first class dry docks shall be: length on bottom, 1,150 ft.; width of entrance, 125 ft.; depth on sill at high water spring tides, 38 ft. A subsidy of 4½% on the estimated cost of $5,500,000 is allowed, payable half-yearly for 35 years from the time of completion. By this amendment no bonds or debentures are to be issued until $1,000,000 shall have been expended on the construction of the dry dock.

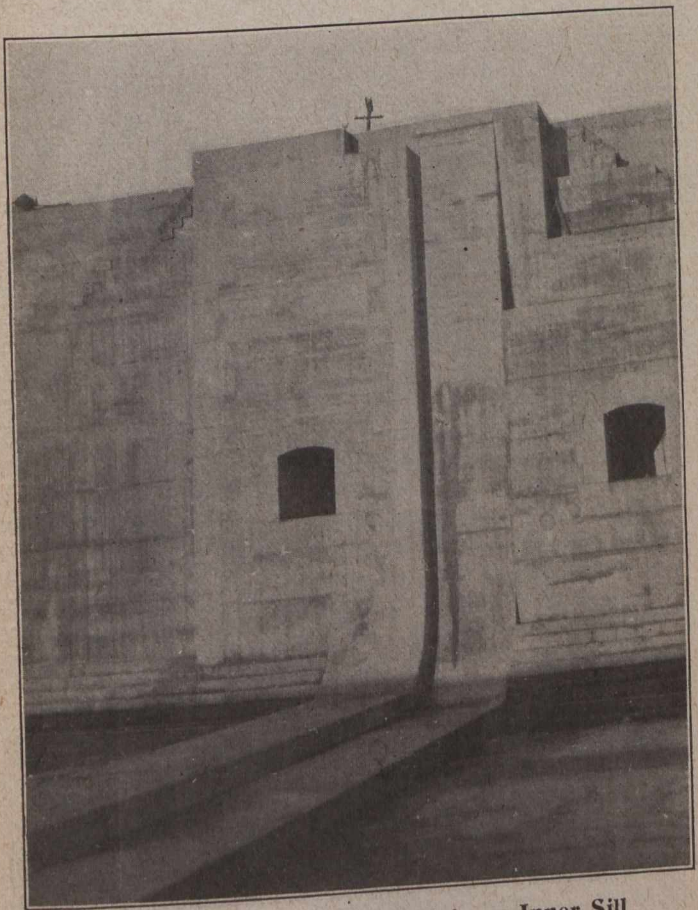
After the passing of the act of 1910, shipbuilding firms were invited to build a dry dock at Lauzon, in Quebec harbor, under the subsidy act of that year. Two companies submitted plans and offered to build under contract

Typical Plan and Sections of Dock, Showing Excavations



without reference to the subsidy act. In 1912 another company submitted plans for a dry dock to be built on the Quebec side of the harbor, just below the mouth of the St. Charles River, according to the subsidy act, as amended in 1912. Some objection having been made to this location and with no prospect in view for any other applicant, the Public Works Department decided that a dry dock would be built by the government.

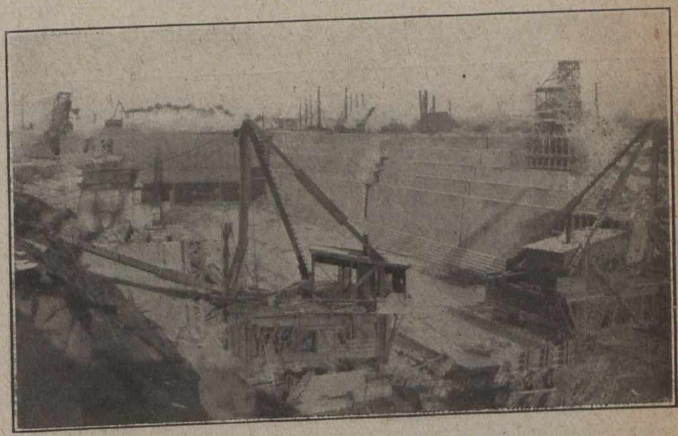
In the early part of 1913 the writer was instructed to prepare plans and specifications on which tenders could be called as soon as possible for the construction of the new dry dock, the location being to the eastward of the Davie shipbuilding yard, so that both the old and new dry docks would be easily accessible from the shops. Tenders for the construction of this work were advertised on May 12th,



Filling Culvert at Floating Caisson Inner Sill

1913, to be received on June 30th, 1913. The contract was awarded to the lowest tenderers, M. P. & J. T. Davis, and was signed on October 7th, 1913. The new dock was at first intended to be built on a line parallel to the old dry dock, but this was objected to from the point of view of navigation. A commission was appointed in the autumn of 1913 to investigate and find out which direction would best suit the entrance facilities, and it was decided that the central line of the dock should form an angle of 69° with the direction of the old dry dock, or approximately 45° n.e., and it was so laid out. Owing to the limited time available before the calling of tenders, general plans only were prepared, together with an estimate of the cost. The requirements as to details for the machinery and caissons were stated in the specification; the contractors were requested to furnish during construction all detail plans, to be submitted for approval by the department. The dry dock has the following general dimensions: Total length from outer caisson to head wall 1,150 ft., divided into two compartments. Outer part 500 ft., inner part 650 ft.

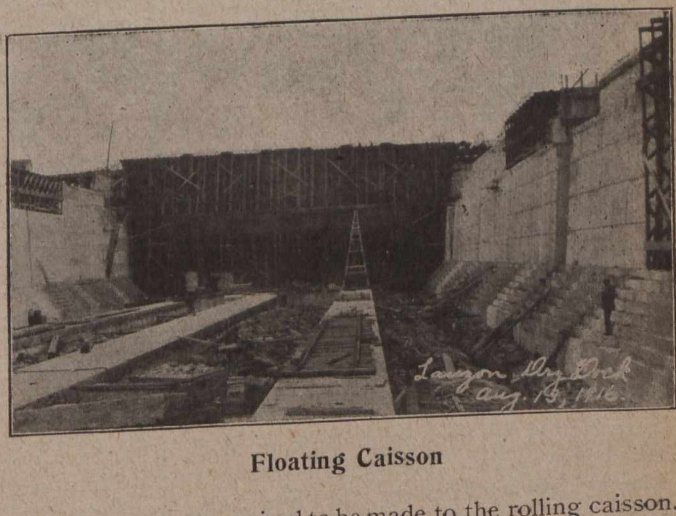
Width of entrance	120 ft.
Width at coping	144 ft.
Width on floor	105 ft.
Depth on sill at high water, s.t.	40 ft.



Erection of the Concrete Walls

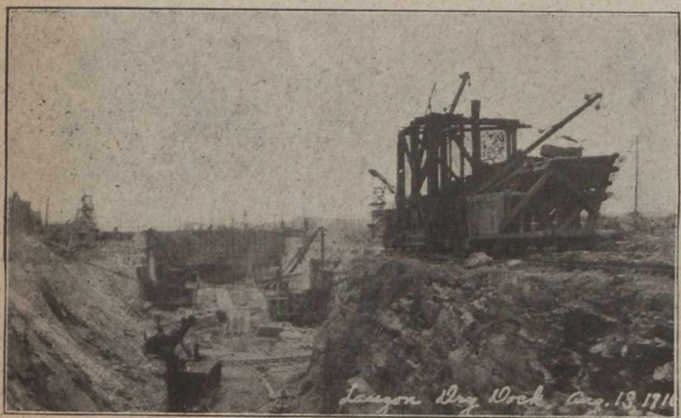
Depth on sill at low water, s.t.	22 ft.
Spring tide rise	18 ft.
Coping of side wall above high water, s.t.	7 ft.
Floor at outer end below outer sill	4½ ft.
Slope of floor traversely	1 in 100
Western guide pier	400 ft.
Eastern guide pier	500 ft.
Depth of entrance channel at low tide	30 ft.

The land expropriated in connection with the construction of the dry dock has a superficial area of 25½ acres, of which 11½ are reclaimed beach land. The outer entrance of the dock is closed with a rolling caisson, the top of which is provided with an automatic folding bridge; a floating caisson closes the inner entrance. This caisson can also be placed to close the outer entrance in cases



Floating Caisson

when repairs are required to be made to the rolling caisson. Three main centrifugal pumps, each of 63,000-gallon-a-minute capacity, are used to empty the dock; two pumps of 6,000 gallons a minute each are used to keep the dock dry. All pumps are run by electric power. Eight boilers of a total capacity of 3,600 h.p. furnish the steam at 200 lbs. pressure to run the three direct current turbo generators of 1,500, 750 and 300 kilowatts respectively, which furnish the current at 550 volts to run the pump and other motors. A direct current generator of 100 kilowatts at 220 volts, driven by a steam engine, will furnish the current for the lamps around the dock and in the buildings. There are 24 lamps of 500 watts, hung from poles around the dock. The poles are made of gas pipe, with the lower end set into sockets fitted with electric connections, and made removable in case of necessity. All electric wiring for lamps and motors outside of the buildings is placed underground. The approximate quantities



The Rock Excavation was Heavy

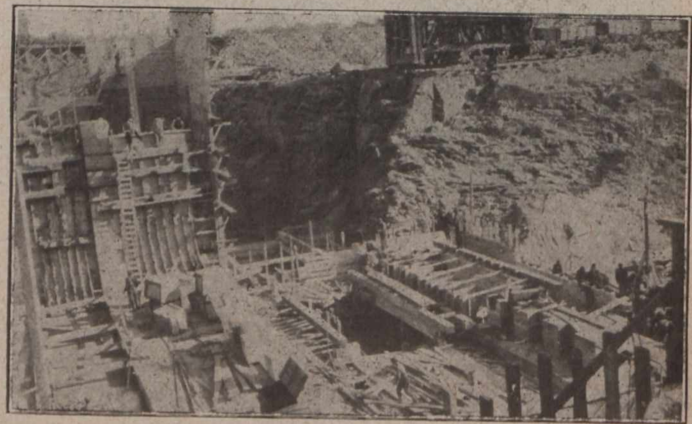
of the materials in the principal items entering into the construction are:

Rock excavation above and below coping	342,000 cu. yds.
Submarine rock excavation in channel ..	65,000 cu. yds.
Dredging entrance channel	530,000 cu. yds.
Concrete	100,000 cu. yds.
Granite steps, altars and quoins	140,000 cu. ft.
Steel beams, reinforcing bars and manhole covers	150,000 lbs.
Cast iron for roller casings and sluice valves	125 tons
Cast steel for caisson roller	65 tons
Gun metal for caisson roller and valves.	4,500 lbs.
Cast iron in keel blocks and bollards	990 tons
Forged steel spindles for rollers	11,000 lbs.
Bricks for chimney and flues	345,000
Fire bricks	125,000
Cribwork in approach piers	63,300 cu. yds.
Concrete in approach piers	13,300 cu. yds.
Steel in rolling caisson	930 tons
Total weight in rolling caisson and machinery	1,125 tons
Steel in floating caisson	960 tons

The work was started in May, 1914. The concrete retaining walls on each side of the dock, specified to be built from the natural rock surface to elevation +24 and intended to prevent seepage through the filling, were completed during the season's work, as well as the cofferdam between the outer ends of these walls. Rock drilling in the prism of the dock was also carried on in the part not affected by tides. The largest part of the drilling was done by two well drillers, the holes being sunk down to grade and plugged for future blasting. The average depth of perforation for each drill was about 80 ft. a day, although as much as 130 ft. was done occasionally. Ten or twelve ordinary steam drills were also used on the work. The rock consisted of hard shale, irregularly stratified, at an angle of about 45°. Considerable rock slides occurred on the west side of the cut, which necessitated a much larger quantity of concrete for the dock wall on that side, also the use of rock bolts, to prevent the sliding tendency of this wall. Steam shovels and dump cars were used to remove the blasted rock, which was used for filling, wherever required, on the government property.

The cofferdam was built of timber cribwork, 20 ft. wide, sunk in an average depth of 1 ft. of water, at low tide, and built to the elevation of 3 ft. above high tide; a layer of concrete was deposited along the bottom of the outer face and this face was sheathed with plank. The floor and walls of the dock are built of concrete, the mixture being 1 : 3 : 5. All exposed faces are finished with a fine concrete of 1 : 2 : 4 mixture for a thickness of 6 ins. The concrete for the walls and the floor was cast in alternate sections of approximately 30 ft., with expansion joints. All the cement used was subjected to a laboratory test; apart from other requirements the tensile strength was required to be 600 lbs. a square inch after 27 days immersion, for neat briquettes, and 275 lbs. a square inch for 1 : 3 mixture.

The steps at the toe of the walls are built of granite, with treads and risers of 12 ins.; the altars are 2½ ft. wide and consist of granite 12 ins. thick, tailing 9 ins. into the concrete. The caisson stops of both entrances and all culvert openings are built of granite. The floor is 5 ft. thick and finished level from end to end; the sides slope down 6 ins. to the side gutters. The floor is provided with three strips of granite slabs, 18 ins. thick, intended to receive the cast iron keel and bilge blocks. The middle strip is 10 ft. wide and level; the side strips are 9 ft. wide. In order to prevent the possibility of hydrostatic pressure under the floor and behind the side walls, a system of drains is provided, that will take the seepage water to the sumps. There are 12 stairways from the top of the walls to the floor of the dock, two at each end of the two compartments and two half-way between the ends of each compartment. Four timber slides, built of granite slabs, 18 ins. thick, are provided alongside the last set of stairways. There are also 8 ladders, 4 on each side of the dock, that may be used to reach the floor. These are built with galvanized iron gas pipe, and set in recesses in the walls. The coping of the walls stands at elevation +25, or 7 ft. above high tide. They are provided with



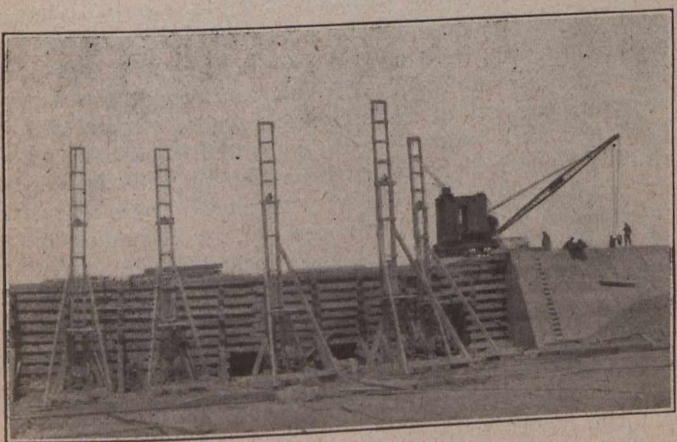
Excavation for Caisson Chamber

the ordinary cast iron bollards, set in concrete blocks, 60 ft. apart. There are 9 electrically driven capstans with 15 h.p. motors, 4 on each side of the dock and one at the head.

The keel blocks are each built of three pieces of castings; the middle piece being wedge-shaped so that it may be knocked out and the block removed from under a ship, when in the way of repair work; the upper part of the top piece of casting is provided with a piece of white oak tenoned into the casting. All rubbing faces are planed true and smooth. The keel blocks are 4 ft. 4 ins. long and 2¼ ft. high. On top of these are placed temporary hard-wood timber blocks to obtain the required height above the floor. It had been intended to build bilge blocks so arranged as to slide under the bilge of vessels. However, this was objected to by the British Admiralty, which insists on having all blocks made of the same pattern, so as to enable building a bed that will conform to the bottom of the vessel.

Caissons

The outer entrance is closed by a rolling caisson built of steel and operated by an electric motor of 125 h.p.; the bottom is provided with two heavy scantlings of steel, resting on flanged rollers, 3 ft. in diameter, placed at 8 ft. centres. These are made of cast steel and bored to receive bronze bushings. The forged steel spindles, 4 ins. in diameter, are also provided with bronze sleeves. The cast iron casings, containing the rollers, are set in the concrete altars, on each side of the caisson berth and chamber. At an elevation of 15¾ ft. above the sill of the dock the rolling caisson is provided with 6 culverts, 42 ins. in diameter, closed by sluice valves that are operated from the upper deck by a 15-h.p. electric motor, driving a longitudinal shaft provided with the necessary gearing; and, by means of clutches, any one or all of the valves may be worked. The culverts are used for flooding the dock. The caisson is divided horizontally by a water-tight deck at the elevation of 23½ ft. above the bottom, forming the ballast and tidal chambers. As the tide rises the sea water comes on this deck through valves in the outer face of the caisson, which are kept constantly open during the summer to prevent the caisson from floating. A sufficient quantity of ballast is provided, so that the total weight of the structure resting on the rollers is approximately 150 tons. During the winter, when the dock is not in operation, the lower or ballast chamber of the caisson is filled with water, which is kept from freezing by a constant jet of steam. The tidal chamber is then kept dry by closing the valves. The caisson is closed and opened with heavy chains, supported on altars on each side of the caisson

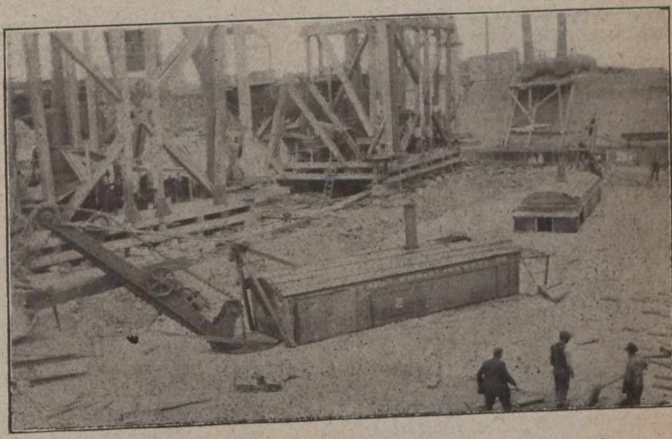


First Drilling in Front of Temporary Cofferdam

recess, and passing over pulleys worked by worm gears connected with the motor. The top of the caisson is provided with a folding bridge for light traffic across the dock; as soon as the caisson starts to open, the apron and railings of the bridge are automatically lowered to allow them to pass under the flooring over the caisson recess. The middle entrance of the dock is closed by an ordinary floating or ship caisson. When in place, the deck is used as a bridge across the dock. This caisson may also be used to close the outer entrance by placing it immediately outside the rolling caisson, where the necessary stop is provided for it. This, however, will be necessary only in cases of repairs being required to the submerged parts of the rolling caisson. These caissons were built by the Dominion Bridge Company, under a sub-contract.

Boilers and Electric Power

Six water tube boilers of 500 h.p. and two of 300 h.p. furnish steam at 200 lbs. pressure to produce electric current.



Start of Excavation Near the Temporary Cofferdam. Shovels Drowned by Infiltration

The boilers are provided with automatic stokers, ash and coal conveyers. The coal is unloaded from cars into a coal crusher run by an electric motor, and elevated to a hopper of 500 tons capacity, over the front of the boilers. Water heaters are provided, but the steam is not superheated; one of the small boilers will be constantly under steam pressure to run the drainage pumps and the lighting dynamo. The electric power consists of 3 direct current turbo-generators of 550 volts, one of 1,500 kilowatts, one of 750 and one of 300 kilowatts. The steam turbines are of the Curtis condensing type, built by the General Electric Co. In the large unit the turbine runs at 3,600 r.p.m. It is geared down to 360 revolutions for the generator; the second is geared from 5,000 to 750; the third is geared from 5,000 to 900 r.p.m. A 100-kilowatt generator driven by a high-speed direct connected steam engine, furnishes the current for lighting purposes. This power installation is more than ample for all the machinery connected with the running of the dock proper. It is, however, anticipated that the whole of it will be used when large repairing and shipbuilding shops are in operation together with the pumping of the dock.

This electric installation has been criticized, on the ground that the large expenditure is not justified when electric current is available from private companies in the vicinity of Quebec. When the electric installation was proposed by the writer the idea in view was that no company would be interested or willing to furnish over 3,000 h.p. at any time of the day or night for the short period of about 50 hours in the year without interfering seriously with their general service. It had also been ascertained by personal visits to five of the principal U.S. Government navy yards that each of them has provided its own electric power for pumping their dry docks. Out of five, only one had installed alternating current machinery. It has developed since that the only electric company that could furnish the power current is not willing to entertain the proposition unless at a much greater cost to the government than the private installation can be run, including the interest on the outlay, which is approximately $240,000.

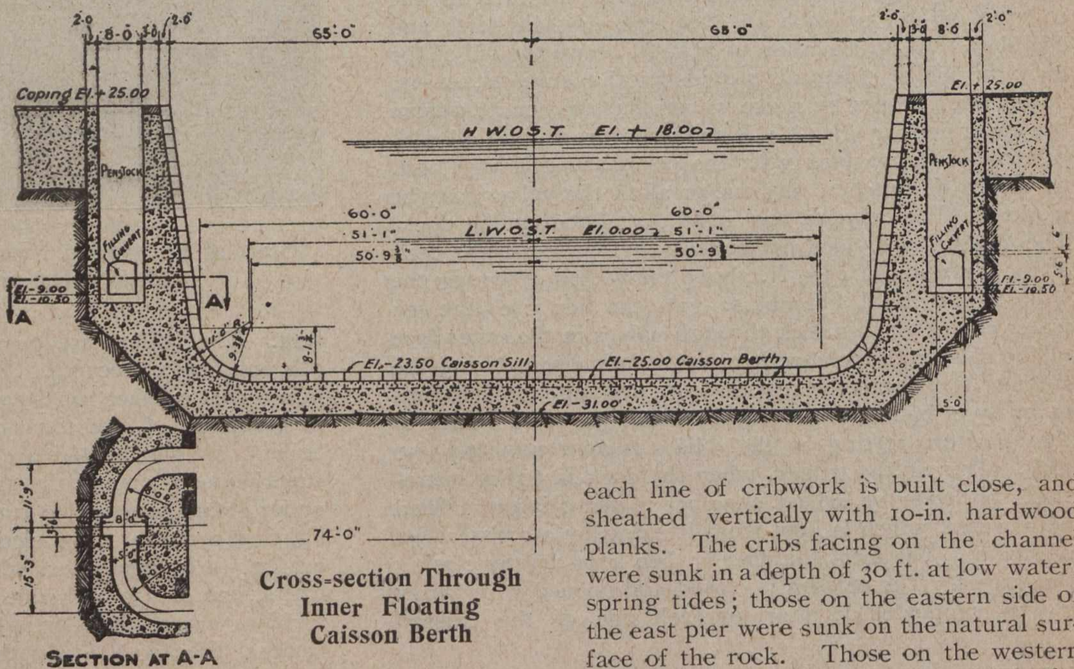
Pumps

The dock is emptied by three main pumps of the horizontal centrifugal type, each having a capacity of 63,000 gallons a minute. The bronze shafts are connected to the armature shafts of 800 h.p. motors, running at 750 revolutions a minute. The motors are built to stand an overload of 25% for two hours; the total lift will very rarely be more than 33 ft. The suction and discharge pipes are 48 ins.; the water is discharged into a chamber provided with non-return valves, and to a culvert through the entrance wall outside of the caisson. The main pumps are guaranteed by the builders to deliver 63,000 gallons a minute against a total head of 25 ft. At the time of writing, these pumps have not been tested as to efficiency. Two auxiliary pumps, each of 6,000 gallons a minute capacity, driven by electric motors of 125 h.p., will take care of leakages and seepage; these pumps will also help while the dock is being pumped. The pumps were manufactured by the Allis-Chalmers Co.

The time occupied in emptying the dock will vary according to the height of tide when the pumps are started and the size of the vessel being docked. At high water of spring tides the dock contains over 38,000,000 gallons of water. This quantity of water, however, will very rarely, if ever, exist, when pumping is started. It is estimated that the average time for pumping out the dock will be about 2½ hours.

Underground culverts 9 x 10 ft. convey the water from the sumps in each compartment of the dock to the pumps; these culverts are provided with sluice gates so as to permit of operating each compartment separately. The gates are operated from coping-level by 15 h.p. electric motors. The pressure against the gates may at times be due to a head of 50 ft. of water. From the non-return valve chamber the discharge culvert is 7 x 12 ft.; it is also provided with a sluice gate. The capacity of discharge of this culvert was obtained from Chezy's formula $V = c\sqrt{rs}$, c being obtained from Kutter's formula. Under a head of 4 ins. the capacity will be ample to take care of the output of the pumps when discharging in open air.

The dock is filled through the 6 culverts in the outer caisson, each having a sectional area of 9 sq. ft., also 2 culverts, one in each side wall of a sectional area of 30 ft., the valves of which are operated by electric power. These culverts are made exceptionally large, due to the fact that each may only be partially opened until the water in the dock has reached the centre of the culvert opening, to prevent the heavy current that would result from a large opening from disturbing the beds prepared to receive a vessel; further, as the head between the outer and inner levels of water decreases, the valves are fully opened, thus obtaining a large flow. The time required to fill the dock may at times be as much as four hours. The middle entrance is similarly provided with filling culverts as the outer entrance.



Cross-section Through Inner Floating Caisson Berth

In order to obtain sea water by gravity for the purpose of washing the floor of the dock, 6-in. pipes were laid in the concrete side walls of the dock, at an elevation of 2 ft. above low tide; each pipe has 6 hose connections and valves at the face of the walls, where 50-ft. lengths of 2½-in. hose may be attached for the purpose. The water is available within one hour of extreme low time. Washing the floor is necessary owing to the sediment accumulated while the dock is flooded.

Guide Piers

The western guide pier is 400 ft. long and 75 ft. wide; the one on the eastern side is 500 ft. long, 75 ft. wide at the outer and 200 ft. wide at the inner end. Each is built of two lines of 12 x 12 timber cribwork substructure up to 6 ft. above low water, spring tides; the outer face of each line of cribwork is built close, and sheathed vertically with 10-in. hardwood planks. The cribs facing on the channel were sunk in a depth of 30 ft. at low water, spring tides; those on the eastern side of the east pier were sunk on the natural surface of the rock. Those on the western side of the west pier, as well as those for the landing pier, were sunk in a depth of 24 ft. at low tide. From the elevation of 6 ft. above low tide the superstructure consists of mass concrete walls, stepped at the back and filled between with excavated material. The railway spur track from the Intercolonial Railway will be extended to the end of the western pier. These piers are intended to be used, when necessary, for unloading parts of cargoes from vessels to be docked. The entrance channel has a depth of 30 ft. at low water, spring tides. The landing pier on the west side of the entrance is intended for unloading the dock supply of coal, when delivered by water.

Buildings

The power house is 120 x 100 ft., divided by a brick wall into two rooms, 120 x 50 ft., one being the boiler room and the other the generator room; the walls are solid brick, built on concrete foundation; the roof is built of reinforced concrete slabs, supported by steel I-beams, which were procured from the unused steel of the first Quebec Bridge. The building is provided with extra large windows with steel frames. Skylights and ventilators are also provided. The floor is concrete, overlaid with red tiles; and the lower part of the interior walls for the generator room is finished with a white tile wainscotting, 6 ft. high. Each room is furnished with water closets and wash basins; the water is obtained from the Lauzon village aqueduct. A special pump in case of fire and the necessary hose are provided. The generator room has an overhead travelling crane of 15 tons capacity. The lifting is done by motor; the travelling gear is worked by hand.

The pump house is 70 x 47 ft., with foundation walls of concrete, over which solid brick walls are built. The floor is at an elevation of 16 ft. below low water, spring tides, or 41 ft. below coping. It is finished with red tiles. The interior walls up to coping level are finished with white tiles. The pump house is also provided with an overhead travelling crane of 10 tons capacity. The chimney is 180 ft. high, built of brick, with an inner shell of fire brick 100 ft. high. There is an air space of 6 ins. between the inner and outer shells; the inside diameter is 11 ft.; the top consists of a cast-iron cap; four lightning rods, well grounded, are provided to protect the chimney.

The length of the dock was decided on not merely in anticipation of vessels of, say, 900 ft. or over being employed on the St. Lawrence trade, which may not happen for a great number of years, but owing to the great number of applications received every fall from owners of moderate sized vessels for accommodation during the winter, so that repairs may be done at cheaper rates, and the boats be ready for traffic as soon as navigation opens.

The dock is not yet quite completed: small portions of the floor and walls at the head remain to be finished; the boilers, machinery and pumps, although in working condition, require some final adjustment before they are tested and accepted;—the rolling caisson was operated in November, 1917,—the contractors' floating plant was docked and the dock was pumped out. It is fully expected that everything will be entirely completed during July.

The several classes of works in connection with the construction of the dock have been accomplished in a thorough manner both in regard to materials furnished and workmanship; several minor changes which were found to be advantageous were made during construction. The contractors, in all cases, have shown their willingness to give satisfaction in every way irrespective of cost. It must be noted that the works were started shortly before the war and continued without interruption, except in winter, in spite of increased cost of materials and labor. The time required for the construction of the dock is somewhat over four years. It must, however, be remembered that the working season is only six months in each year,—concrete works have to be suspended during the first days of November and cannot be resumed until the beginning of May. The total cost of the works under contract will be approximately $3,365,000. The works have been carried on by the Public Works Department, with E. D. Lafleur as chief engineer,—the writer as superintending engineer, and J. K. Laflamme as resident engineer,—S. Fortin, steel structural engineer, has had the approval of plans submitted for the steel structures. The contractors are M. P. & J. T. Davis, and S. Woodard is their superintending engineer.

According to the annual report of the Department of Railways and Canals for the year ended March 31st, 1917, the government railways in operation and their mileage were as follows:—

Intercolonial	1,518.39
Prince Edward Island Railway	275.20
National Transcontinental Railway	1,811.28
Grand Trunk Pacific Railway	191.75
New Brunswick and Prince Edward Island Railway	36.05
International Railway of New Brunswick	111.30
St. John and Quebec Railway, operated but not owned	119.87

DOMINION POWER BOARD

FOLLOWING the discussions of the House a few weeks ago respecting the fuel situation in the Dominion, the government has taken prompt and constructive action to provide for the future needs of the country, insofar as fuel and power are concerned. Recognizing that in the various government departments there are officials who have become expert in various phases of the fuel and power problems of the Dominion, the government has decided to take advantage of such immediately available advice and assistance with a view to co-ordinating all the government activities respecting investigation and administration of fuel and power matters. The Honorable Arthur Meighen, Minister of the Interior, is the chairman of the board, which will be known as the Dominion Power Board. The other members are: Arthur St. Laurent, assistant deputy minister, Department of Public Works; C. N. Monsarrat, consulting engineer of the Department of Railways and Canals; W. J. Stewart, consulting engineer to the Department of External Affairs regarding international waters; John Murphy, electrical engineer to the Dominion Railway Commission; H. G. Acres, chief hydraulic engineer, Hydro-Electric Power Commission of Ontario; O. Higman, chief electrical engineer, Department of Inland Revenue; D. B. Dowling, geologist, Department of Mines; B. F. Haanel, chief engineer, fuel testing division, Department of Mines; J. B. Challies, chief engineer and superintendent, Dominion Water Power Branch, Department of the Interior.

PURE WATER ALWAYS PAYS

DAMAGES amounting to $50,462 have been granted by the courts to the members of the Detroit commandery No. 1, Knights Templar, and their families for sickness caused by drinking polluted water from the Sault Ste. Marie River while on a cruise in June, 1915, on the steamship "South American." After the steamer, which had been chartered by the knights for a cruise to Huffton, had returned to Detroit, an epidemic of typhoid broke out among the passengers. The courts held that the steamship company was responsible for the illness.

The steamship "Faith," the largest ocean-going concrete vessel in the world, arrived in a Canadian Pacific port last week on her maiden trip from San Francisco.

The name of the National Iron Works, Ltd., of Toronto, has been changed to the National Iron Corporation, Ltd. There is no change, however, in the directors or personnel of the company.

According to the franchise of the British Columbia Electric Railway Company, the city of Vancouver may purchase its property and lands, providing it signifies its intention of doing so not later than August of this year. The subject was discussed at a recent meeting of the Vancouver Board of Trade, and a letter addressed to the mayor of the city calling attention to this fact and placing the services of the board at the disposal of the city. The company owns and operates 334 miles of electric railway. It is an English limited company, incorporated in 1897, and carries on under powers conferred by acts of the parliament of British Columbia, a well-established electric railway, lighting and power business in Vancouver, North Vancouver, South Vancouver, Point Grey, New Westminster, Victoria and other adjoining municipalities. Most of the company's securities are held in England. The total share capital issued is £4,320,000, in addition to which there is over £1,800,000 of debentures and debenture stock. This is the largest public utility corporation in the province.

RECOMMENDED CHANGES IN CLAY AND CEMENT SEWER PIPE SPECIFICATIONS

CHANGES in the tentative specifications for cement sewer pipe and also for clay sewer pipe have been recommended by the committee on sewer pipe of the American Society for Testing Materials. Dr. Rudolph Hering, consulting engineer, of New York City, is the chairman of the committee.

The committee recommends that in the case of clay sewer pipe the values in Table 3, "Dimensions," of the society's specifications, be changed as follows:—

Changes in Clay Pipe Specifications

1. *Table III., "Dimensions."*—Change the values in the fourth column on "Depth of Hub" to read as follows (the figures in brackets indicate present values to be revised:

Internal Diameter, in.		Depth of Socket, in.
6		2
8		2½
10		2½
12	[3]	2½
15	[3]	2½
18		3
21	[3½]	3
24	[3½]	3
27	[4]	3½
30	[4½]	3½
33	[5]	4
36	[5]	4
39	[5]	4
42	[5]	4

2. *Section 32.*—Change to read as follows by the insertion of the italicized words:

"The ends of the pipes shall be square with their longitudinal axis, *except as provided in Table IV.*"

3. *Section 33 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

"Curves shall be at angles of 90, 45, *22½* [11¼] deg., as required."

4. *Table IV., "Permissible Variations in Dimensions."* After the second column, insert a new column headed "Lengths of Two Opposite Sides, in." as follows:

Normal Size, in.	Limits of Permissible Variation in Lengths of Two Opposite Sides, in.
6	⅛
8	⅛
10	⅛
12	⅛
15	⅛
18	3/16
21	3/16
24	¼
27	¼
30	¼
33	⅜
36	⅜
39	⅜
42	⅜

5. Substitute the word "socket" for "hub" wherever used in the specifications.

Changes in Cement Sewer Pipe Specifications

1. *Section 31 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

"Curves shall be at angles of 90, 45, *22½* [11¼] deg., as required."

2. *Table III., "Dimensions."*—Change the table to read as follows by the insertion of a new column headed "Normal Annular Space" and by replacing the matter in brackets by the words and figures indicated:

Table III.—Dimensions of Cement-Concrete Sewer Pipe

Internal Diameter, in.	Laying Length, ft.	Diameter at Inside of [Hub], *Socket*, in.	*Normal Annular Space, in.*	Depth of [Hub], *Socket*, in.	Taper of [Hub] *Socket.*	Minimum Thickness of Barrel, in.
6	2	[8½] 8¼	½	2	1:20	⅝
8	2, 2½, 3	[10⅞] 11	⅝	[2½] 2¼	1:20	[⅞] ¾
10	2, 2½, 3	13¼	⅝	2½	1:20	[1] ⅞
12	2, 2½, 3	[15½] 15⅝	⅝	[3] 2½	1:20	[1 3/16] 1
15	2, 2½, 3	19¼	⅝	[3] 2½	1:20	[1½] 1¼
18	2, 2½, 3	22¾	⅝	[3] 2¾	1:20	[1¾] 1½
21	2, 2½, 3	26½	¾	[3½] 2¾	1:20	[2] 1¾
24	2, 2½, 3	30¼	¾	[3½] 3	1:20	[2⅜] 2⅛
27	3	34	⅞	[4] 3¼	1:20	[2⅝] 2¼
30	3	38	1	[4½] 3½	1:20	[3] 2½
33	3	41½	1	[5] 4	1:20	[3¼] 2¾
36	3	[45¾] 45½	1¼	[5] 4	1:20	[3½] 3
39	3	[49¼] 49	1¼	[5] 4	1:20	[3¾] 3¼
42	3	[53¼] 53	1½	[5] 4	1:20	[4] 3½

[1] When pipes are furnished having an increase in thickness over that given in last column, the diameter of [hub] *socket* shall be increased by an amount equal to twice the increase of thickness of barrel.

3. *Table IV., "Permissible Variations in Dimensions."* Change the values in the third and fourth columns, on "Spigot" and "Hub," to read as follows (the figures in brackets indicate the present values to be revised):

Normal size, in.	Limits of Permissible Variation in Internal Diameter, in. Spigot ±.		Socket ±	
6		3/16	[¼]	3/16
8		¼	[5/16]	¼
10		¼	[5/16]	¼
12	[5/16]	¼	[⅜]	¼
15	[5/16]	¼	[⅜]	¼
18	[⅜]	¼	[7/16]	¼
21	[7/16]	5/16	[½]	5/16
24	[½]	5/16	[9/16]	5/16
27	[⅝]	5/16	[11/16]	5/16
30	[⅝]	⅜	[11/16]	⅜
33	[¾]	⅜	[13/16]	⅜
36	[¾]	½	[13/16]	½
39	[¾]	½	[13/16]	½
42	[¾]	½	[13/16]	½

4. Substitute the word "socket" for "hub" wherever used in the specifications.

Trent Canal, from Lake Ontario to Lake Simcoe, was formally opened last week. The Minister of Railways and Canals and members of his party were tendered a banquet at the Empress Hotel, Peterborough. Among those who accompanied the Minister on the trip were C. N. Monsarrat, chief engineer, Quebec Bridge Commission; W. A. Howden, chief engineer of Railways and Canals; E. Guss Porter, K.C., M.P.; and Chief Engineer Phillips, of the Rideau Canal.

REINFORCED CONCRETE SHIPS*

By A. Alban H. Scott
Vice-President, Society of Architects

STEEL shipbuilders look upon reinforced concrete as a very complex matter, chiefly owing to the large number of small rods and the overlap required to get continuity, but in comparing the form of jointing in reinforced concrete work to the riveting in steel ships and the caulking required one would perhaps be justified in thinking that it might be impossible to get a comparatively water-tight ship with steel plates, when it is considered that for a ship to, say, 1,000 tons D.W. for the hull alone there would be approximately 2,500 separate sheets and angles of steel used and somewhere in the neighborhood of 110,000 rivets.

The approximate number of bars in a reinforced concrete vessel (same D.W.) would be 52,000.

Testing of Materials is Important

The testing of materials for reinforced concrete ships is one of extreme importance, and the Concrete Institute's report on this subject should be carefully studied. The whole of this report is applicable to shipwork, except that the maximum size of the coarse material requires, in the opinion of the writer, to be reduced to ⅜ in.

Additional tests are desirable as to the impermeability of concrete, and also as resistance to shock.

In several references to reinforced concrete ships one notices the phrase that "concrete is poured in," and in the opinion of the writer the loose application of this term should be combated. To obtain the best results, concrete should be *placed* into position as dry as possible, and after the concrete has been so placed, and sprinkled with water the result is a material much stronger and much more waterproof than a wet, sloppy mixture, or even a mixture which might be termed plastic; for this reason one would much sooner adopt the method of elevating the practically dry, mixed material in preference to delivery by gravitation.

Materials Required

A good deal of discussion has been taking place as to the suitability of various sites for the construction of reinforced concrete vessels. It is necessary to consider first the materials involved. If we take a boat of, say, 1,000 tons D.W., we find we shall require approximately 40 tons of clean, fresh water, free from injurious foreign matter, 564 tons of aggregate, 234 tons of sand, 125 tons of cement, 160 tons of steel, and 138 tons of material for equipment in the way of machinery, etc. It is clear, therefore, that the combined weight of the sand and aggregate is 66 per cent. of the total required, including equipment. It would consequently appear desirable, so as to save the cost of freightage and the difficulties of transport, that waterways for these shipyards should be looked for in the neighborhood of suitable stone quarries, where crushing plants could be put down and trolley-ways or rope-ways for transporting the material from the quarry to the shipyard could be arranged. It is also possible that cement could be obtained in the immediate district. If concrete in a relatively plastic condition be finally chosen such a method of transport from the quarries to the vessel obviously suggests that the material should be lifted above the ships, and after being mixed at a convenient level the concrete should be transferred by gravity to each particular vessel and part of the vessel requiring concrete at the moment. This method, however, the author suggests, requires too great a percentage of water.

With this new form of construction for vessels the temptation to depart from true ship lines must be resisted. For many years investigations have been carried on to ascertain the lines which give the least resistance to a ship passing through water; and because a different material is proposed to be used for certain boats it is submitted a great mistake would be made by departing from proper and regulated lines of the ship in the expectation of securing economies in construction in reinforced concrete. Safety and efficiency in running must be the first considerations. To depart from proper ship lines would involve extra expenditure on the running costs, which would quickly neutralize any saving on the capital outlay of the ship when constructed. No doubt it would be found that if five or six boats were built with the same set of centering there would be no additional cost by having what is known as "circular circular work." It has been stated that it is more difficult to get the reinforcement into position by following the true ship lines than if straight lines are adopted. The obvious reply to this is, that it is more difficult to construct upper stories to a building than lower stories, therefore we won't have any upper stories, or if it is more difficult to provide for hatchways, leave them out.

"Flour" Should Be Eliminated

The importance of testing each individual material used in reinforced concrete cannot be too strongly emphasized.

The following results of tests might be of interest:—

By kind permission of the publishers the following extracts are given from my previously published book, "Reinforced Concrete in Practice."

"It is important that 'flour' should be eliminated from the sand. The actual size of the grains of sand in the concrete has a material effect on the strength of the work. Table No. 15 indicates the amount of surface to be covered by the cement."

	Materials passing through a mesh of the following diameters. Inches.		Approximate total surface area of the particles contained in each cubic foot of material. Square inches.
Sand.	0.0066	Should not be used for R.C. work.	1,530,000
	0.013		792,000
	0.025	....	412,000
	0.04	....	268,000
	0.06	....	194,000
	0.13	....	98,000
	0.25	....	45,000
Aggregate	0.37	....	28,000
or coarse	0.5	....	21,000
material.	0.62	....	16,000
	0.75	....	13,600

These areas are taken on the assumption that the grains have smooth and even surfaces, and no allowance has been made for irregularities of any description; they should therefore be considered as the minimum area.

Grading the Material

The amount of voids in the aggregate and sand when mixed renders it necessary to exercise the greatest care in grading the material. To ensure good compact concrete the voids should be reduced to the lowest percentage com-

*Abstracted from paper read before the Concrete Institute, May 9th, 1918.

patible with the elimination of "flour." The following table is the average of three determinations:—

	Percentage of voids.
Passing ¾-in. and retained on ⅝-in.	48.2
⅜-in. to ½-in.	44.5
½-in. to ⅜-in.	43.4
⅜-in. to ¼-in.	42.9
¼-in. to ⅛-in.	39.8
⅛-in. to 1/16-in.	39.0
1/16-in. to 1/32-in.	35.5
1/32-in. to 1/50-in.	34.5
Pit sand all passing ¼-in., retained on 1/50-in.	30.2 to 23.3
Broken granite passing ⅜-in., and retained on ¼-in.	47.6 / 32.3
10 parts broken granite, all passing ¾-in. and retained on ¼-in., and 5 parts Leighton Buzzard sand, all passing ¼-in.	22.6

PALMERSTON WATERWORKS*

By A. E. Davison
Manager Municipal Department, Ontario Hydro-Electric Power Commission

ORIGINALLY the town of Palmerston, Ontario, obtained its water supply by means of air-lift pumping from two 8-inch wells, but the quantity thus raised became inadequate to serve the growing needs and during the first half of 1916, the local authorities consulted the Hydro-Electric Power Commission of Ontario on the subject of increasing the supply.

Several schemes were thought of, the two chief ones being as follows:—

1. To install a deep well pump.
2. To install a centrifugal pump.

The first was abandoned, since it was found that in order to obtain the 300 or 400 Imperial gallons per minute required, a 12-inch well would be necessary, and this meant boring a new well, which it was desired to avoid.

The second presented the difficulty that careful estimates based on the data at hand showed that the water level, when the required quantity of water was being pumped, would be about 40 feet below the surface of the ground, and as a centrifugal pump does not work satisfactorily with more than about 18 feet of suction, the use of such a pump would involve the sinking of a caisson around the well large enough to accommodate the pump and motor.

It appeared, however, that this scheme might be feasible, although it was realized that trouble would be encountered owing to the presence of quicksand some distance below ground level.

Finally a recommendation was made to the local authorities that a caisson around one of the wells be sunk about 30 feet deep and 8 feet in diameter and that in it should be suspended a vertical pump and motor, the pump to be at the bottom of the caisson and the motor near the top.

The local Water and Light Commission having given the Hydro-Electric Power Commission authority to proceed on this basis, plans and specifications covering the requirements were issued and tenders were obtained, the contract for the pump and motor going to the Canadian Fairbanks-Morse Company, Limited. The pumping equipment comprised the following:—

(a) One 4-inch, 2-stage, vertical centrifugal pump, capable of delivering 400 Imperial gallons per minute of clean, fresh water against a total head of 125 feet, with a guaranteed efficiency of 55 per cent., the speed being 1,435 revolutions per minute.

(b) One 30-h.p., 3-phase, 25-cycle, 550-volt, vertical, squirrel-cage, moisture-proof, induction motor, having a guaranteed efficiency of 87 per cent. at full load.

(c) Vertical steel framework, steady bearings, ball-thrust bearings, etc.

The work of excavating and making the caisson was undertaken by the town with the advice of the commission, a wood lining at first being tried; owing, however, to difficulties due to quicksand and the presence of some large boulders, as the work proceeded downwards the commission's engineers recommended a steel caisson, specifications for which were issued. This steel caisson was purchased from the National Equipment Company, of Toronto, and as soon as it was received the work was continued to a successful conclusion, though not without further difficulties due to quicksand being met.

The pump and motor, having passed the tests at the maker's works, were shortly afterwards installed and started up. A few minor troubles were experienced at that stage but were very soon set right and the equipment has now been operating quite satisfactorily since the first two or three weeks after installation—a period of some twelve months.

A small housing has been built over the caisson and electric lamps illuminate the interior. In order to install this equipment, the air-lift pumping plant at one of the wells has, of course, been dismantled, but the other remains intact for use in emergencies.

A very slight seepage of water into the caisson takes place, and to deal with this, a small gear pump has been installed; but it is only operated infrequently.

The entire cost of the work, including the surmounting of the troubles experienced with the quicksand, was approximately $3,400. As showing the financial advantage of having carried out this work, it may be said that information received from Palmerston indicates that whereas formerly the cost of coal for pumping was some 720 tons per annum at $4.45 per ton ($3,204), the cost for electric current is now about $876 plus 12 tons of coal at $10.50 (this price for coal seems high but does not seriously affect the saving of $2,200 shown if reduced to the figure used below, *viz.*, $7) which represents a saving of $2,200 per annum in operation alone. It may safely be added that there is no increase in any other costs, such as labor or repairs, tending to offset this favorable result.

The saving as above does not represent the true state of affairs for 1917, since, had the old method of pumping been in use, the gain would have been about as follows:—

720 tons of coal at $7 per ton = $5,040; while for electricity, assuming coal at the same price (*viz.*, $7 per ton) the cost would be $876 plus $84 = $960, showing a saving of over $4,000 for the year.

*From the Bulletin of the Ontario Hydro-Electric Power Commission.

Among the Canadian patents recently issued through the agency of Ridout and Maybee, Toronto, are the following: H. E. Angold and Wm. Duddell, distance operated mechanisms, and signals connected to electric supply systems; Henry P. Baird, air moistening and filtering attachment for radiators; G. and J. Weir, Limited, control device for rotary pumps.

PRELIMINARY ANALYSIS OF THE DEGREE AND NATURE OF BACTERIAL REMOVAL IN FILTRATION PLANTS*

By Abel Wolman
Division Engineer, Maryland State Department of Health.

THE determination of a law of bacterial removal by rapid sand water filtration plants is of great practical importance and utility. Such determinations of plant efficiencies are valuable as indicators not only of present but also of future performance. The objection is, however, often justly raised against the attempt to predict quantitatively the possibilities of bacterial removal, that existing numerical measures of performance are misleading and in some cases even harmful. The calculation of percentage removal from raw water to efficient is an illustration of the type of measure which has arithmetical accuracy, but little logical basis. It is quite evident, however, that it would be desirable to measure quantitatively the performance of a plant in such a way as to obtain a comparative conception of how well or how badly it is being operated. Since at present no agreement exists among operators, designers, or public health officials as to a standard of "good performance"—because in the past, agreement has been prevented by the interminable search for a "standard effluent," itself the subject of disagreement—it becomes necessary to attack the problem of rating or standardizing plant accomplishment from another angle. In this discussion, an initial search is made for certain basic characteristics of rapid sand filtration. The term "rapid sand filtration" is here used more broadly than usually, to describe the entire process from preliminary coagulation through sedimentation or settling, filtration, and disinfection. The measure of variable phenomena by comparison with ideal or "normal" conditions is a procedure common to scientific analysis. The application of this method offers here a fruitful means of testing our ideas of filtration efficiency. The first problem obviously consists in the attempt to determine a possible correlation between the number of bacteria in the final effluent of a filtration plant and the number in the raw water. A numerical statement of a problem should be clearer. If a plant uses a raw water containing 500 bacteria per c.c. and produces an effluent containing 10 per c.c., will the same plant produce an effluent of 20 per c.c., when the raw water content is 1,000 per c.c.? Can one predict, in other words, with any degree of precision, what effluent counts should be normally attainable with varying raw water counts?

Normal Empirical Performance

The normal or ideal performance from which it is possible to obtain hypotheses as to standard empirical accomplishment is not difficult to deduce. The "normal empirical performance" may be defined as the accomplishment of a filtration plant which is known to be operating successfully. Successful operation can be said to exist wherever there is an unquestioned superior bacteriological and physical quality of effluent, consistent performance, excellent control, and scientific observation of operating details. In this analysis, the operating statistics of the filtration plant at Avalon, Maryland, owned by the Baltimore County Water and Electric Company and operated by Mr. S. T. Powell, were used. This plant obtains its raw water from the Patapsco River, a highly polluted stream, ranging in turbidity during the year from 0 to 5,000 parts per million and in bacterial content (20° C.—gelatine—48 hours), from several hundred to 150,000 per c.c. The watershed of the stream is composed largely of cultivated areas, with no large sewage polluting influences. This water is treated with aluminium sulphate, at an average rate of 0.8 grain per gallon, and is then allowed to settle for four hours. After leaving the sedimentation basin it is treated with calcium hypochlorite with an average dose of 0.34 parts per million, and then passes through the rapid sand filters which have a capacity of 2.5 million gallons per day. The plant is controlled scientifically by a trained operator with the aid of modern equipment and laboratory observation. During several years of operation the bacterial content of the effluent has not exceeded, at any time, 20 bacteria per c.c. Presumptive tests for B. coli in lactose broth have indicated positive tests in 1 c.c. less than 2 per cent. of the time during any year. The number and kinds of bacteria are determined in raw water and final effluent every day and general experimental data are constantly collected. It is clear, therefore, that the plant in Baltimore County approaches so closely, from the standpoint of operating results, the ideal plant as to justify the use of its performance as the basis of a law of filtration.

In order to determine with some degree of accuracy the form of a characteristic empirical performance curve, the results of raw water and final effluent counts of the Avalon plant were plotted. In order to avoid plotting, a mass of points which would tend to confuse seven-day averages of both stations, rather than daily results extending over a period of nineteen months in 1915, 1916 and 1917, were used. In plotting these values, approximately 520 daily analyses were summarized. These were obtained in consecutive months and under every phase of operating conditions. No counts were discarded as being unfair or incorrect.

The equation of a straight line, when the results have been plotted on a logarithmic basis, *viz.*, given by:

$$C = \frac{\log y}{\log x},$$

where C is a constant for this particular plant, and y and x are respectively the raw water and final effluent counts. It would appear, therefore, that the "normal empirical performance" is represented by a curve having the equation

$$C = \frac{\log y}{\log x} \text{ or } y = x^c.$$

A tentative hypothesis, with regard to bacterial removal by filtration action, may be promulgated, therefore, as follows: "The final effluent count, under normal operating conditions, is an exponential function of the raw water count." This hypothesis provides a means of determining whether or not a plant under scrutiny is, at least, "performing normally," where normal performance would be interpreted as conformity to the logarithmic curve of filtration.

A Fallacious Assumption

The "normal performance" curve demonstrates the fallacy of assuming that the difficulty of removal of bacteria is relatively the same regardless of the number of bacteria in the raw water. Although this assumption is rarely publicly proclaimed, it is usually summoned, however, to the aid of those plants which, for one reason or another, are so unsuccessful as to require a specious hypothesis, fairly reasonable to the layman, to support their claims to maximum efficiency of 99 per cent. plus. The practical results of a scientifically controlled plant certainly seem to lead to the conclusion that increases in raw water bacterial content decrease the corresponding

*Abstracted from a paper read before the St. Louis Convenion of the American Water Works Association.

bacterial content interval in the final effluent. It should be added, too, that the equation of normal performance

$$C = \frac{\log y}{\log x}$$

offers a new quantitative measure of the efficiency of any plant, obtained by evaluating in any case the constant, C. Such a measure, among other qualities, has the advantage of a rational basis and a practical significance.

Value of Coefficient of Efficiency

What absolute value this constant, C, or the so-called "coefficient of efficiency," should attain is dependent upon individual opinion of "good performance." It is of interest to note, however, that, in a survey of 19 rapid sand filtration plants, varying in size from 2.2 to 30.0 million gallons filtered per day, the coefficient of efficiency of 17 of these plants has attained an annual average of over 2.5. The raw waters which these plants had to treat contained turbidities ranging from an annual average of 1 to 561 parts per million, and average bacterial contents from 350 to 16,500 per c.c. The 19 plants chosen, therefore, for the evaluation of C, are representative, in their initial conditions, of rapid sand filtration. The probable existence of the law of filtration, $y = x^c$, combined with known values of C, practically attainable, gives the investigator of filtration plant accomplishment the fundamental criteria with which to measure both the character and the amount of removal in any particular plant. The objection may be raised to the above method of critical standardization of plants, that all do not function in a similar manner, on account of differences in raw water, resulting from peculiarities of suspended matter, variations in resistance of bacteria, and other similar factors. The objection does not seem to the writer to be entirely valid, since peculiar characteristics of raw water are usually provided for by variations in design, such as increased periods of sedimentation and greater doses of disinfectant. It is reasonable to suppose, therefore, that given plants, initially properly designed for local conditions, should function according to some common law, since death rates under disinfection, devitalization and sedimentation, and filtration of bacteria differ in the degree, but not in the kind, of changes effected. The preliminary theory of bacterial removal by filtration is supported by the average monthly results from several large rapid sand plants in the United States. Since the death-rate of bacteria under the action of disinfectants, and under well-defined conditions, has been shown to follow in general the law:

$$C = \frac{1}{t^2 - t^1} \log \frac{y^*}{x},$$

it will be necessary to look for the causative factors of $y = x^c$ LAW in other phases of the system of rapid sand filtration. It is the writer's purpose to study further the bacterial removal in the individual and distinct processes of coagulation, sedimentation, and filtration proper, with a view to throwing further light on the problem of causation. Strictly speaking, the equation of a straight line curve plotted on logarithmic axes is $y = bx^c$, where b is the intercept on the y axis. In that case, C becomes

$$\frac{\log v - \log b}{\log x} \text{ rather than } \frac{\log y}{\log x}$$

Log b is infinitely small in our particular problem, since b, the intercept on the y axis, would be equivalent to those raw water counts which produce resultant final effluent counts of one. Since zero counts are rarely obtained in filtration plants, even with extremely low raw water counts, it is conceivable that the performance curve in the "normal operation" described above would intercept the y axis at some point approaching unit. Log b, therefore, would approach zero and could be neglected in the evaluation of C. It is evident, therefore, that

$$C = \frac{\log y}{\log x}$$

measures in each case, with sufficient accuracy, the slope or inclination of the performance curve, the significant index to the efficiency of bacterial removal.

FIREPROOFING SPECIFICATIONS

LAST year the committee on fireproofing of the American Society for Testing Materials submitted to that society a new tentative method for control of fire tests and classification of materials and construction as determined by test; also certain revisions of the existing standard tests for fireproof floor construction and for fireproof partition construction. In order that the proposed new standards should be as generally acceptable to the engineering world as possible, a series of conferences were inaugurated with representatives of the following technical organizations:

American Society for Testing Materials, National Fire Protection Association, U.S. Bureau of Standards, National Board of Fire Underwriters, Underwriters' Laboratories, Associated Factory Mutual Fire Insurance Companies, American Institute of Architects, American Society of Mechanical Engineers, American Society of Civil Engineers, Canadian Society of Civil Engineers, American Concrete Institute.

The recommendations of the committee comprised the joint action of the representatives of all these organizations. The results were very gratifying, and the work has been continued this year in the same co-operative way. Two conferences have been held.

The U.S. Bureau of Standards and the Underwriters' Laboratories conducted numerous experiments during the year investigating the adaptability of the proposed time-temperature curve for the control of fire tests. The curve operated so satisfactorily it was unanimously voted to make no change in it, nor in any other essential feature of the proposed new requirements.

The standards have been rearranged and simplified to some extent for sake of clearness, and the revisions of existing standards have been amplified to make them more definite. These changes, however, have not altered the general purpose of the requirements as submitted in tentative form last year.

The committee recommends that the proposed standard specifications for fire tests of materials and construction be referred to letter ballot of the society for adoption as standard. The effect of their adoption will be to discontinue existing standards and incorporate the whole subject of fire tests of materials and construction under one set of specifications.

The following is a report of the steel output of Canada in 1917, compared with two previous years, the December figures of last year being estimated:—

	1915. Tons.	1916. Tons.	1917. Tons.
Steel ingots	989,829	1,397,703	1,686,005
Direct castings	31,067	30,546	42,807
Total steel	1,020,896	1,428,249	1,728,812

The relative output of electric steel was as follows:—

	1915. Tons.	1916. Tons.	1917. Tons.
Electric steel	5,625	19,639	39,069

BOMBARDMENT OF PARIS*

By Robert K. Tomlin, Jr.
Formerly Managing Editor, Engineering Record of New York

WHEN the first bombardment of Paris by the long-range German gun followed a night of bombing by enemy airplanes, no one at that time realized that shells were being sent into the city from a point behind the front line trenches, which are at least 75 miles from the centre of the city. I was out on the streets the morning the bombardment began and everybody was under the impression that it was a daylight air raid, something entirely new, as of course all of the previous air raids had been engineered under cover of darkness. The sky above Paris was thick with French fighting planes, scooting here and there in search of enemy machines. It was not until late that day that we realized that the explosions did not come from bombs. The excitement was intense and everyone was mystified, for explosions were occurring at regular intervals of about twenty minutes, and no enemy machines could be spotted overhead.

Use Subway as a Refuge

The regular *alerte*, which is a warning sounded at the approach of German bombing machines, was given early in the morning, and both the "Metro" and the "Nord-Sud," the two Paris subways, were shut down in order that the stations, platforms and underground tubes could be used as a refuge by the people of Paris. The tramways, or street railways as we would call them, stopped operation. Cars were emptied, motormen and conductors left their platforms, and the rolling stock was left standing in the street wherever it happened to be when the *alerte* was given. Traffic was absolutely paralyzed and the only wheels turning were those of the taxi-cabs.

As a matter of fact, the shutting down of the subways in order to furnish underground retreats for the population defeated the very purpose for which it was done. In an hour or two, people got tired of staying under ground and came up for a breath of fresh air. Many of them had to get from one part of the city to the other, and the only way of doing this was by walking along the streets. Therefore, with the subways shut down, there were far more people on the streets and subject to danger from explosions of shells than would have been the case if the lines had continued their normal operation. This fact evidently was appreciated later, for during succeeding bombardments by the long-range gun, the subway system has continued in operation.

Bombs Do Most Damage

The damage done by the long-range gun is much less than that which results from the dropping of bombs by an airplane. I have seen a good many of the buildings hit by the long-range shells and they seem to damage only the upper two stories. The bombs, however, wreck things to a greater depth, sometimes as much as four stories. It often happens that when a shell strikes, the panes of glass on the opposite side of the street are shattered, while those on the same side remain intact.

Detonations of explosives are such a regular event here that the storekeepers are going to great trouble to protect their windows from breakage. The favorite stunt seems to be to paste across the glass long strips of paper. It has been interesting to watch the development of this form of protection. Originally two diagonal bands were pasted across the window. Then someone with an artistic touch got busy and produced a design of squares and triangles like the strips of pastry on an old-fashioned cranberry pie. He soon had a large following and now the windows present designs of every conceivable pattern. It seems to me that these Parisian shop-keepers have something to learn in the matter of window protection from New York merchants, whose stores were situated along the excavations for the new subway lines. There, it will be remembered, the favorite trick was to truss the panes with diagonal wires and struts at the centre. I have yet to see one of these rigs in service here. The gummed strips of paper, however, apparently have official sanction for the windows of the Ecole Nationale des Ponts et Chaussées are "dolled up" in this way.

The city authorities are busy providing shelters or *abris* for the people during air raids. These are generally cellars of buildings not less than four stories in height. On the entrances to buildings containing cellars which have been officially designated as *abris* are big paper placards indicating the capacity of the shelter. Going along any street in Paris now you see on the buildings these placards with the words "150 places," "80 places," etc. Some of the cellar *abris* had window gratings fronting on the streets. At the present time all of these are being blocked up with plaster to intercept shell splinters.

Although the subway is now kept running during daylight bombardment by the big gun, it is closed down during an air raid at night. Those people who seek underground shelter on such occasions now take the experience pretty much as a matter of course, and during the last raid I saw people filing down stairs into the Etoile station of the "Metro" with camp-stools, chairs, newspapers and magazines, and other aids to comfort during the two or three hours sojourn below street level.

"La Grosse Bertha"

When a night air raid starts, the fire engines are sent at full speed through the streets with their sirens going full blast, church bells outside of Paris start ringing, and factory whistles add to the discord. New stationary sirens are in course of installation. Pretty soon the anti-aircraft guns start booming on the outskirts of Paris and from my window I can see the flash of the shells as they burst in mid-air. It looks just like the bunch of sparks produced in grinding metal with an emery wheel. In twenty minutes or so after the guns have started the airplanes which have managed to break through the barrage begin to "lay their eggs." It is very easy to distinguish between the detonation of bombs and the burst of the shrapnel from the "Archies." The bomb makes a deep roar while the shrapnel produces a higher staccato note.

Paris is not greatly disturbed by the shelling of "le canon à longue portée" which is generally dubbed by the French newspaper writers as "La Grosse Bertha." People go about their business very much as usual. The moving pictures are taking a fling at the big gun in a humorous way. At the last performance I attended there was shown an "animated cartoon" in which "La Grosse Bertha" was sending over shells and Charlie Chaplin (whom they call Charlot over here) was catching them, standing forth as the defender of Paris. After he had caught three of these the cartoon showed him juggling them, and finally hurling them back in the direction of Berlin.

While many persons have departed from Paris as a result of the air raids and bombardment, the bulk of the populace is taking the matter calmly. I have yet to see anything in the nature of a panic.

*A letter written to the Engineering News-Record of New York.

COL. LOW RESIGNS AT HALIFAX

GEO. H. ARCHIBALD, of the firm of Archibald and Holmes, Ltd., engineers and builders, Excelsior Life Bldg., Toronto, has been appointed manager of the reconstruction department of the Halifax Relief Commission in place of Col. R. S. Low, who has resigned.

Having completed practically all of the work of the commission which needed urgent attention, and, in fact, having completed practically all of the work of the reconstruction department excepting the rebuilding of the devastated area, Col. Low felt that his work of organization of the department had been completed and that he should resign in order to devote attention to the affairs of his own company, which has taken on some very important contracts recently, including the new Federal Office Building in Ottawa, a $1,000,960 contract, and the big plant at Deschene, P.Q., for the British-America Nickel Corporation, which he is to complete before snow falls.

Col. Low has given six months' time without remuneration to the Halifax Relief Commission. He told the commission when he assumed control of the reconstruction department, that he would be able to stay only until the more urgent affairs had been disposed of, and that he would not be able to supervise the town planning or reconstruction of the devastated area.

SEWER PROJECT AT MONTREAL

REPORTING in favor of an improvement scheme to cost $1,632,997, a commission which has inquired into the sanitary conditions of the River St. Pierre, Montreal, states that this amount could be reduced by adopting tunnel methods on the part of the work under the Lachine Canal. The report on the plan has been prepared by J. H. Valiquette, engineer in charge of the western division of Montreal, and one of the members of the commission.

The plan is divided into five sections, the estimates for which are as follows: 1, River St. Pierre intercepting sewer, tail race of the aqueduct to St. Ambroise Street, $640,000; 2, Pressure conduit attached to River St. Pierre intercepting sewer, to take care of Westmount intercepting sewer, $194,000; 3, Inverted syphon under Lachine Canal, $520,000; 4, Westmount intercepting sewer, $206,478; 5, Deepening of channel outlet, $72,519.

It is believed that this scheme will do away with the floods and noxious smells which have been a menace to public health in the district drained by the River St. Pierre. Mr. Mercier, chief engineer of Montreal; Mr. Roy, engineer of St. Pierre aux Lieux; Mr. Laframbroise, engineer of Lachine; and Mr. Lafreniere, engineer of the Quebec provincial board of health, were members of the commission.

Regina, Sask., will vote on a by-law to spend $175,000 on extensions to the municipal electric light and power plant.

Building permits issued at Welland, Ont., for the month of May, 1918, totalled $93,029, compared with $37,846 for the corresponding month last year. The total for the year 1918 to June 1st is $176,724, compared with $133,195 for the same period last year.

Sorel, P.Q., may have a new pumping plant and also a filter plant at a later date. E. Gill, town engineer, has drawn plans for improving the aqueduct and for the installation of new pumps to replace the existing ones. One pump will have a capacity of 1,500,000 Imperial gallons per day to be used for domestic supply, and the other will have a capacity of 3,500,000 per day for fire protection.

HIGHWAY MATERIALS PUT ON FAVORED LIST FOR U.S.A. CAR DISTRIBUTION

HIGHWAY materials have been placed next to coal, coke and ore, on the preferential list for car supply, by the car service section of the railroad administration of the United States Government. This ruling applies particularly to stone, sand and gravel for maintenance and essential road construction. The aim is to assure the proper care of roads already built, and the construction of those necessary for the carrying on of the war. The regulations issued are as follows:—

1. Open top cars, suitable for such traffic, should be furnished preferentially for the transportation of coal, coke and ore.

2. Available open top cars, not suitable for the transportation of coal, coke and ore, may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials.

3. Open top cars, suitable for the transportation of coal, coke and ore, and available on coal, coke or ore producing roads in excess of the demand of such commodities, may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials. The return movement to mines or ovens should be utilized wherever practicable in furnishing car supply for stone, sand and gravel. Every endeavor should be made, consistent with keeping up the production of coal, coke and ore, to furnish shippers of stone, sand and gravel with a minimum of forty per cent. of their normal weekly transportation requirements.

4. Roads which are not producers of coal, coke or ore must not use foreign open top equipment for stone, sand or gravel shipments, except for one load in the course of the return movement to mines or ovens.

5. Where the transportation needs of essential road construction or maintenance projects cannot be met by car supply furnished in accordance with the above rules, the state, county or municipal officials in charge of the work, should, through their proper state highway department, apply to the Director of the Bureau of Public Roads, United States Department of Agriculture, Washington, D.C., for assistance. Such applications will be considered by representatives of the Department of Agriculture, the War Department, the War Industries Board, the fuel administration and the railroad administration, and in accordance with the recommendations of such representatives, the Car Service Section will endeavor to furnish car supply necessary for approved essential road construction or maintenance.

It must be understood that car supply for stone, sand and gravel must not be permitted to jeopardize the essential production of coal, coke or ore. If at any time such a result is apparent on individual roads, or generally, orders will immediately issue to curtail the car supply for stone, sand and gravel.

Madigan & Darbyson, engineers and contractors, have dissolved partnership, W. H. Madigan continuing the business on his own account with office at 30 St. John St., Montreal.

The arbitration between the Cook Construction Co. and the city of Montreal to assess the damages caused by the cancellation of the contract for the construction of the aqueduct, and by the breaking of the water conduit, has now been concluded. The arbitrators are J. M. Fairbairn, W. F. Tye and A. Geoffrion, K.C. The arbitrators visited the conduit and also heard evidence from several United States and Canadian experts.

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

JAMES J. SALMOND, *President and General Manager* — *ALBERT E. JENNINGS*, *Assistant General Manager*

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

Principal Contents of this Issue

TRADE RESTRICTIONS MAY PROVE BENEFICIAL IN DEVELOPMENT OF NATURAL RESOURCES

TRADE restrictions announced by Canada's War Trade Board will have a salutary effect upon manufacturing conditions in Canada. More raw materials will be worked into marketable commodities instead of being exported to the United States and then imported again as manufactures. As stated by Mr. Edward T. P. Shewen, of St. John, N.B., consulting engineer to the Public Works Department of Canada, in his contribution to the eighth annual report of the Commission of Conservation: "In exporting raw material, a country derives from its natural products the least advantage."

Referring to this aphorism, Mr. C. E. W. Dodwell, of Halifax, in his contribution to the report of the Committee on Conservation presented at the last annual meeting of the Canadian Society of Civil Engineers, says that this enunciation is a flash of genius, entitling Mr. Shewen—until and unless he disclaims originality—to the Nobel prize for the year or the Cordon Bleu of the Academy. "The only proper way in which Canada can ever hope to pay the interest, to say nothing of the principal, of the numerous loans that have been raised to justify and maintain our proud position in the Empire," says Mr. Dodwell, "will be to exploit and develop on sound business principles the almost unlimited natural resources within our borders.

"Take the crudest but most forceful case. A ton of pig iron to-day is worth about $56; converted into watch springs it is worth nearly $40,000. In the process of conversion it is increased seven-hundred fold in value. The enormous sum of nearly $40,000 has been added to its value, this sum representing the difference between its actual and its potential value.

"This is admittedly and purposely an extreme case, but the principle underlies the whole subject. A cord of pulpwood is worth six or seven dollars. Ground into pulp it is worth about $20; converted into paper, even the cheaper form of wrapping paper, it is worth over $200. A ton of gypsum is worth a couple of dollars. Calcined and ground, and thus converted into wall plaster, it is worth about $16, an eight-fold increase."

These are but three of numerous similar examples which could be quoted. In order to grapple vigorously with these and other problems, and to insure proper co-ordination of effort, Mr. Dodwell suggests that a new department of the Federal Government be created. He would call it the Department of National Development, or the Department of Conservation and Development, or the Department of Development and Industry, or the Department of Conservation and Industries. In it he would group and co-ordinate the Commission of Conservation, the Honorary Advisory Council for Scientific and Industrial Research, the Fuel Testing Laboratories, the Forest Products Laboratories and all other government branches or sub-departments which are connected with any feature of development or research. He suggests that the new department be manned by a staff of scientific men and fully equipped with funds for carrying on extensive research work in many branches of scientific industry.

DOMINION POWER BOARD

IN accordance with the resolution passed at the last annual meeting of the Canadian Society of Civil Engineers, the Dominion Government has appointed a Power Board to co-ordinate the development of fuel and power. The government is to be congratulated upon its action. Such a board is necessary to ensure the greatest economical advantage from the use of our national resources.

Few other countries are so fortunate in the advantages accruing from splendidly located water power and coal, and few countries have used such advantages to so great an extent as the people of Canada. During the period of the war, there have been many unfortunate but, it is hoped, temporary difficulties in meeting the urgent demand for fuel for domestic purposes and power for manufacturing. Unless a deliberate attempt be made to have the use of our water powers and our fuel resources co-ordinated, and a policy evolved which will realize such co-ordination in the years to come, the recent difficulties in fuel and power needs will be aggravated. The government has, therefore, taken a wise step in constituting a permanent board for the consideration of problems of such vast importance to all parts of the Dominion.

Cheap power promises to be one of Canada's greatest assets in the post-bellum industrial rivalry of nations for world trade. Our fuel resources, supported by our water powers, should be a sure source of cheap power, and should guarantee Canada her share in world trade, if they are availed of to their maximum possible advantage.

MOBILIZING CANADIAN LABOR

IN mobilizing the nation's full labor power, the government has taken proper action. The times demand deeds, not words. The fate of liberty-loving nations trembles in the balance. Recalling with just pride what her sons have accomplished, fully assured that their courage will meet every test, that their will for victory is inflexible, Canada with quiet confidence will do her duty in this hour of crisis and of peril.

We are convinced that every man, woman and boy has a present supreme duty to the State—the duty of performing useful, productive work. Distinctly war work must come first in the country's economic programme; the production of munitions, clothing, ships, and food and the scores of accessories required for efficiently carrying on the war. Thereafter, and after all primary demands have been met, the machinery of production must be kept in full operation to the end that the wealth essential for financing national requirements, on war account, will be forthcoming.

The mere possession of property, or income from investments, gives no one the right during these hard days to live a life of leisure. Not for an instant can the people of this country forget or neglect the men who are giving their all that liberty and justice may not perish from the earth. The vast majority of men of means have done their part. The others must.

Methods have been devised under a recent order-in-council to eliminate the shirker and all others who are voluntarily idle. Magistrates everywhere should relentlessly enforce the provisions of the law.

Senator McCumber recently introduced a bill into the United States Senate providing for the registering of all male citizens between the ages of 16 and 62, and for subjecting them to "the call of the government to perform such service in transportation, ship-construction and war-supplies as the government might require." This bill, in all probability, will not at present be made the law of the land, as it embodies the principle of industrial conscription. Nevertheless, the American nation will not permit the word "conscription" to terrify it, if circumstances demand drastic action. Their military record proves that beyond any possibility of doubt. Within six weeks of the declaration of war the draft measure was on the statute books.

The Canadian administration likewise does not propose the conscription of labor at this juncture. Nevertheless, conscription will come if it be found essential for the winning of the war. France and the United Kingdom have had virtual conscription from the outbreak of hostilities. Workmen were not free to move from place to place, and from trade to trade, as in peace times. In the United Kingdom, as is well known, a workman could not hope to leave his job and get employment elsewhere unless he had secured a certificate showing that he had been honorably discharged.

PERSONALS

J. W. SHACKLETON has been appointed city engineer of Chatham, Ont.

F. L. BUTLER has been appointed general superintendent of the Winnipeg Electric Railway, succeeding Wilson Phillips.

A. R. WEBSTER, formerly of the Northern Ontario Light and Power Co., has been appointed inspector of mines for Ontario.

C. H. LEE, of the British Columbia Electric Railway, has received a commission as lieutenant in the U.S. Navy Civil Engineering Corps.

JOHN VASS has been appointed assistant master mechanic of the Ontario lines of the Grand Trunk Railway with headquarters at Allandale, Ont.

Lieut. HAROLD JOHN MACKENZIE, a graduate of the School of Practical Science, 1914, who went overseas with the 1st Tunnelling Company Canadian Engineers, has been decorated.

BRIG.-GEN. F. O. W. LOOMIS, of D. G. Loomis and Sons, general contractors, Montreal, was included in the list of those honored on the King's birthday. He was made a Companion of the Bath.

M. W. PLUMB has resigned as managing engineer of the Pneumatic Concrete Placing Co. of Canada, Limited, Montreal, to accept a position in the traffic department of the Emergency Fleet Corporation, New York City.

Capt. GEORGE C. BLACKSTOCK, of Toronto, has been awarded the Military Cross. He was a student in engineering at the University of Toronto in the class of 1915, but enlisted immediately after the declaration of war.

W. H. FARRELL, terminal superintendent of the Grand Trunk Railway in Toronto, is severing his connection with the company to assume the position of general manager of the Algoma Eastern Railway Co., with headquarters in Sudbury, Ont.

Lieut. J. S. GALBRAITH, of the 123rd Pioneers, who came home from France a couple months ago on sick leave, is to get his discharge as physically unfit. Lieut. Galbraith is a son of the late Dean Galbraith, of the School of Practical Science, Toronto. He graduated in 1913 in civil engineering at the University of Toronto. He served in France for eighteen months but was invalided home after a gas attack.

T. H. HOGG, assistant hydraulic engineer of the Hydro-Electric Power Commission of Ontario, will address the Association of Municipal Electrical Engineers at the first regular meeting of that association, to be held at Niagara Falls, Ont., June 14th and 15th. Mr. Hogg's subject will be "The Chippewa Creek Power Development Scheme." After his description of the project, the delegates will be motored over the site of the proposed power canal.

O. W. MEISSNER, of Montreal, and C. N. SCHRAG, of Toronto, are organizing a new manufacturers' agency firm to be known as Equipment Specialties, Limited, successors to O. W. Meissner, Limited, of Montreal. Mr. Schrag recently resigned as sales manager of the Bawden Pump Co., of Toronto. The new firm will have offices at 10 St. Antonie Street, Montreal, and 1409 Royal Bank Building, Toronto. Among the agencies secured are the following: Gardner Governor Co., Quincy, Ill., duplex steam pumps and air compressors; Homestead Valve Mfg. Co., Homestead, Pa., plug cocks; C. M. Davis Regulator Co., Chicago, Ill., pressure reducing valves, governors, altitude and back-flow valves; Metallium Refining Co., Omaha, Neb., jointing for water and sewer pipes; Moore Steam Turbine Corporation, Wellsville, N.Y.; Mulconroy Co., Philadelphia, Pa., hose and other mechanical rubber goods; A. Wyckoff & Son Co., Elmira, N.Y., wood-stave pipe and steam pipe casings; and Pacific Coast Pipe Co., Vancouver, B.C., (agency for Ontario, Quebec and East) wood-stave pipe and tanks.

OBITUARIES

RAYMOND CHARTRAND, a former contractor, died June 4th, in Montreal. Mr. Chartrand was 82 years of age. He was the contractor for the post-office, the court house and many other public buildings in Montreal.

GEORGE FEE died on May 25th at his residence in Westmount, P.Q. Mr. Fee retired about fifteen years ago from the firm of George Fee & Co., railway contractors, who completed a section of the C.P.R. in 1885.