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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Construction Methods Used at Drummondville

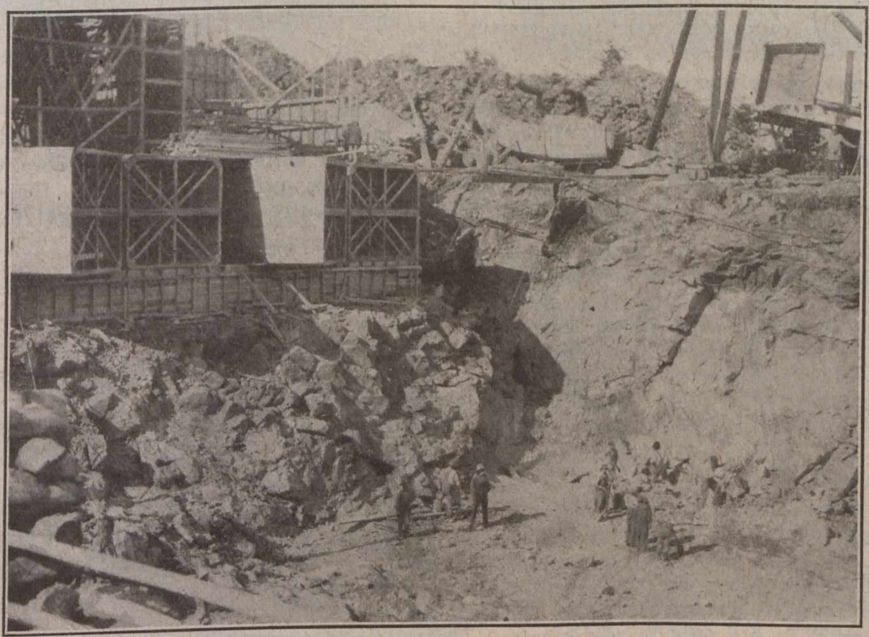
In Damming the St. Francis River and Building Power House to Develop About 19,000 h.p.—2,900 ft. of Cofferdams Required for 1,890 ft. Dam—Concrete Distributed Over Long Distances in V-Shaped, Steel Cars During Winter

By JAMES DICK
Resident Engineer for the Contractors

CONSTRUCTION work has been completed on the hydro-electric power development for the Southern Canada Power Co., Ltd., situated on the St. Francis River at Drummondville, P.Q. The general layout of this development was described in *The Canadian Engineer* for January 30th, 1919.

The company is now provided with an additional 7,000 h.p. to meet the growing demand for power in that territory. The dam and the headworks of the power house are built to provide for the full capacity of the plant, which will be attained when the remaining two units of 6,000 h.p. each are installed.

The accompanying drawing shows the general plan of the work and the layout of the construction plant. There is a continuous fall in the river from the site of the old dam to below the highway bridge north of the railway. The placing of the power house near the latter point utilized the full head available, with the crest of the new dam at the same elevation as that of the old.



EXCAVATION FOR POWER-HOUSE

The total length of the dam as constructed is 1,890 ft. and is longer than the length planned owing to certain changes made in its direction in order to secure better foundation and economical construction; of this length, 1,340 ft. runs in a direction practically parallel to the river.

With the exception of 260 ft. of stop-log section, comprising ten sluiceways 20 ft. wide, separated by piers, the dam is an overflow type, with a maximum height of 16 ft. The crest is 12 ins. wide and the greatest width at the base is 19 ft. The portion between the stop-log openings and the railway is of a wider section owing to the tunnel running throughout its length, which provides means of access to the deck of the stop-log section.

The diversion of the flow toward the west bank of the river submerges a considerable area of land lying adjacent to the tunnel section, and to provide a suitable waterway through this to the forebay, considerable excavation had to be done. The material was a sandy clay mixed with boulders and varied in depth from 3 to 6 ft., overlying very irregular ledge rock. This was removed in carts and scrapers, after which all rock ridges and points were levelled to a given elevation, and in addition a channel 45 ft. wide and 6 ft. deep was cut through the rock, extending from the original shore line to meet the excavation in the canal under the railway bridge.

One of the chief features of construction was the large amount of cofferdam work that had to be done, particularly in the unwatering of the dam. This work was further complicated by the necessity of keeping the old power plant in operation. In all, 2,700 ft. of this class of work was required, 800 ft. being placed to unwater the site of the tail race excavation, and the remaining 1,900 ft. for the dam. The latter amount was increased by 1,000 ft. which represented the rebuilt portions swept away by heavy floods, on one of which occasions the flow of the river increased from 7,000 to 60,000 cu. ft. per sec. in a period of 12 hours.

About 75,000 lineal feet of round timber was used in the construction of the cofferdams, all of which material was cut off the property of the company adjacent to the work.

The cofferdams were built in sections, the cribs being from 20 to 25 ft. in length. Accurate soundings were taken over the site of each crib and the framing of the first few courses of timber was done on the sounding raft, from which the crib was floated into position and loaded with rock placed on the pole-ballast floor, the additional courses of logs required being added as the crib settled into place. The stream-face timbers were dressed to a true face and were all placed in the same vertical plane, to provide an even bearing for the sheet piling. Two-inch plank was used for sheeting, which was placed in the deeper parts of the river by divers.

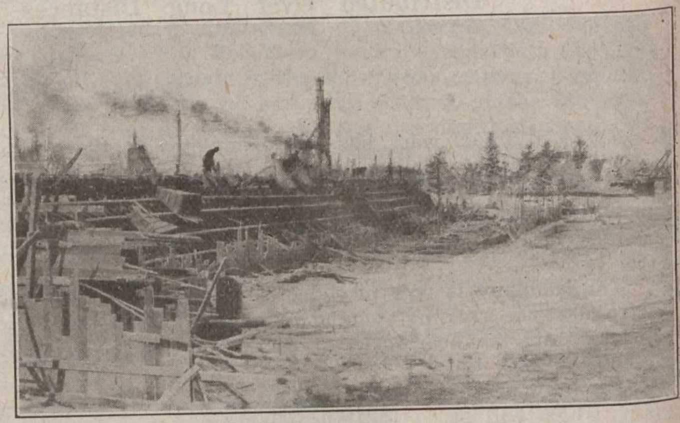
Throughout most of the length of the dam, the bed of the river was very rough, being strewn with large boulders. This condition made considerable work on placing the sheeting, as much of the boulder accumulation had to be removed.

Placing Cofferdam Cribs in January

On the section of cofferdam built to unwater the site of the stop-log section and part of the spillway, instead of completely enclosing this area, the cribbing was continued downstream for some distance, to a point where the normal water elevation was lower than the bed of the river at the site of the foundations. This did away with the necessity of pumping out a large area, inasmuch as the section shut off from the river drained completely with the exception of a slight seepage through the cofferdam, which was conveyed away from the foundation excavation in ditches.

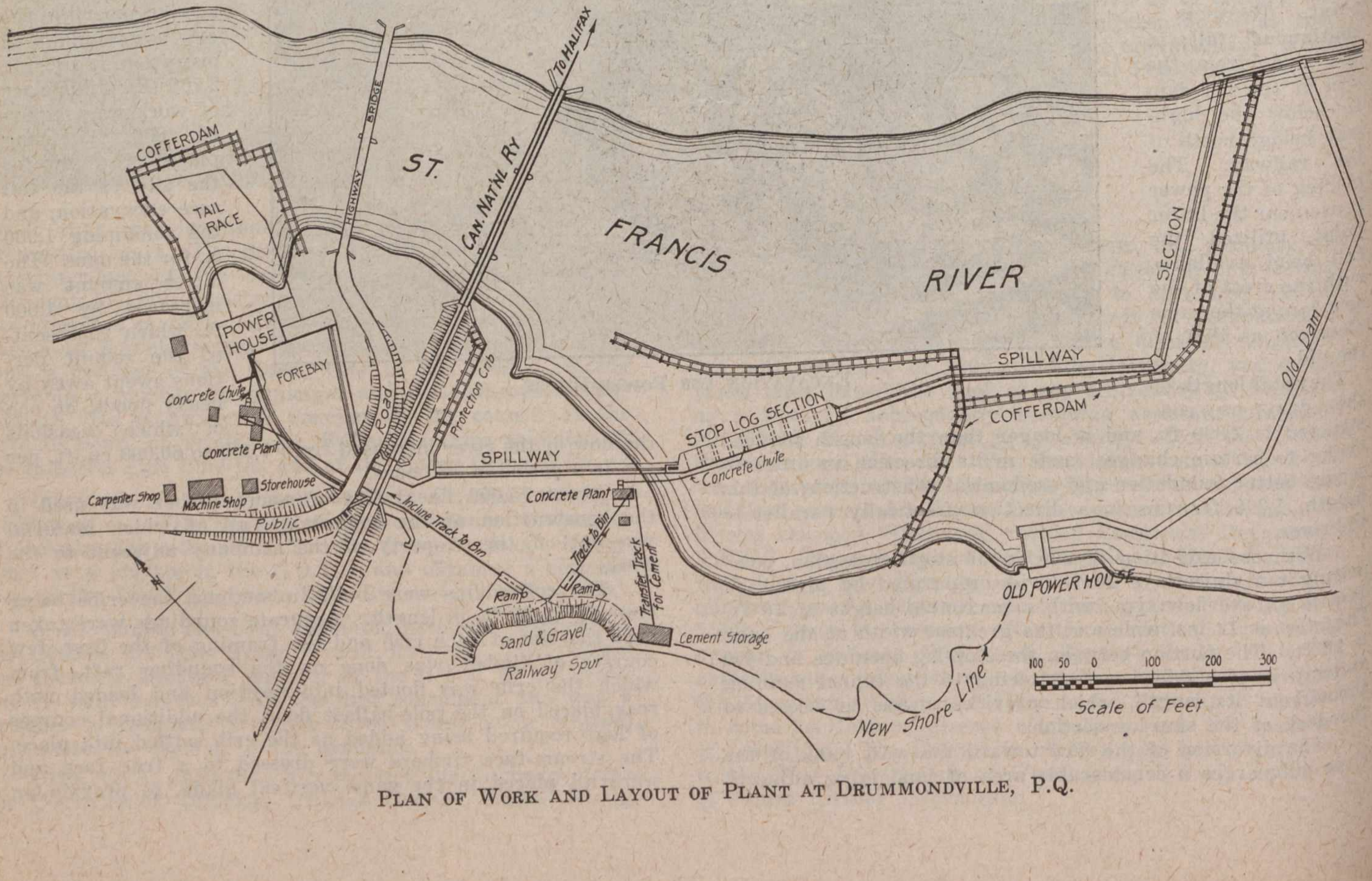
As soon as the concrete work was completed inside this cofferdam, sections of it were removed permitting the water to pass through the stop-log openings. The cofferdam work was then continued, paralleling the dam all the way across the river, and on its completion diverted the flow through the completed portion of the dam. The delay caused by floods had advanced the work on this part of the unwatering into the winter season, and in consequence large quantities of ice had to be removed before the cofferdam cribs could be placed. A considerable length of this work had to be built in and parallel to a very swift rapid, and it was found that owing to the rough bottom and the presence of fissures in the rock, there was considerable leakage. To unwater the foundation effectively a double row of sheeting, 24 inches apart, was placed along the line of the upstream and downstream face of the masonry footing. Two-inch plank was used for this and was held in place between 3 by 4-inch wales, the whole being thoroughly braced inside and out. The space between rows of sheeting was thoroughly puddled.

The foundation excavation for the dam varied in depth, the maximum being 9 ft. through a heavy deposit of gravel and boulders overlying a stratum of very compact silt next to the rock. The work was performed in sections of



Constructing the Dam

from 30 to 50 ft., the material being loaded into skips handled by a steam-operated derrick. Owing to the nature of the material excavated, there was a certain amount of seepage into the excavation. This was pumped out by an electrically-operated centrifugal pump.



Plan of Work and Layout of Plant at Drummondville, P.Q.

On account of the uncertain weather conditions prevailing during the performance of the work on the last 800 ft. of the dam, and the possibility of further floods, a condition not unknown during the winter (the river in February, 1914, increased from 9,000 to 64,000 cu. ft. per sec. in a short time), every effort was made to expedite the work; and as a result, the unwatering, preparation of foundation and the placing of 3,300 cu. yds. of concrete were done in 46 days. Concrete was placed, on the average, at the rate of 160 cu. yds. a day, and the distance transported from the mixer to the forms was from 400 to 1,200 ft.

Concrete Materials and Placing

Two mixing plants were installed, one adjacent to the power house, serving that building and the forebay walls as far as the railway crossing, and the other near the end of the stop-log section of the dam.

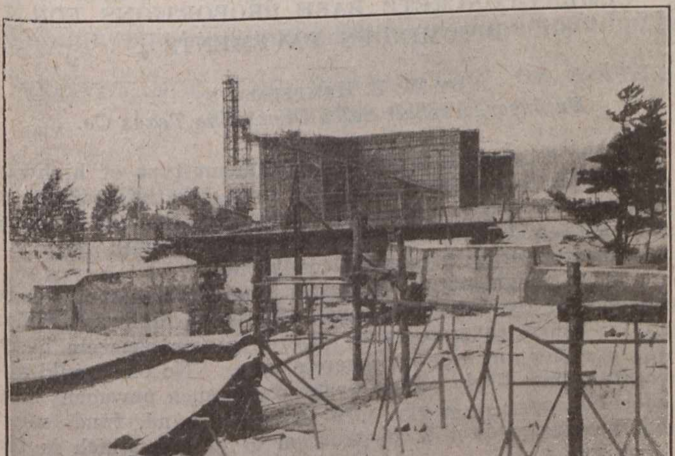
In addition to these, a mixer was operated for a short time on the east bank of the river and supplied concrete for the side wall, also a short section of the dam at that point.

The two mixing plants were identical in construction and equipment. A steam-operated Smith mixer of ¾ cu. yd. capacity was located underneath the charging floor at the foot of the hoisting tower by which the mixture was hoisted and deposited into a distributing hopper having a capacity of 2 cu. yds. Two of these were in place, one at the top of the tower for distribution by a chute and the other at the foot for delivery into buggies for transporting the concrete to work not served by the chutes. Sand and gravel were used for aggregate. Some crushed stone was used with these in the power-house work.

The aggregate was contained in a bin at the back of the mixing plant, the material being delivered to the charging hopper above the mixer by chutes.

Sand and gravel were brought in by rail, and to deliver these materials into a stock pile as close to the work as possible, an extension of about one-quarter of a mile was made to an existing spur from the railway main line. From the stock pile the material was transferred to the bin at the mixing plants in 1 cu. yd. side-dump cars, operated by cable from a hoist at each mixing plant, the return being by gravity.

The cars were charged from loading bins placed adjacent to the stock pile. These bins were about 30 ft. long with a capacity of 30 cu. yds., and were elevated sufficiently to permit the cars to travel underneath, the loading being



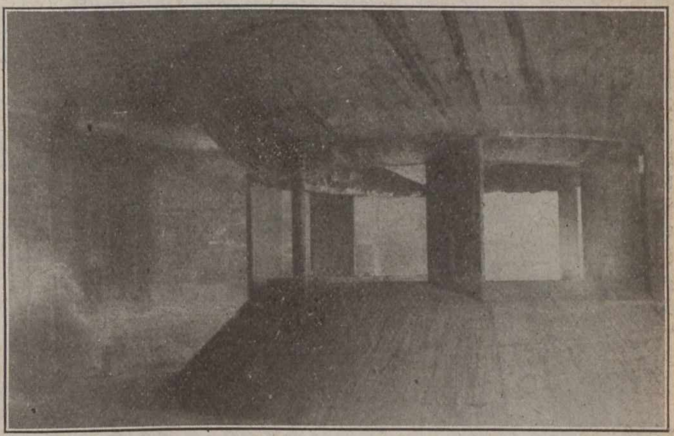
POWER-HOUSE AND ENTRANCE TO FOREBAY

controlled by slide gates in the bottom of the bin. A ramp constructed of 2-in. plank on a timber foundation was placed between the bins and the stock pile. The material was conveyed up this to the bins by a scraper, similar to the ordinary grading scraper but of heavier construction, operated backwards and forwards by cable from a double-drum hoisting engine. This worked very satisfactorily and the whole operation was controlled by the hoist runner. The scraper was adjusted so that it would trip automatically at the edge of the bin and the only attention the apparatus required was the moving of the back block from time to time, in order to keep the scraper working close to the face of the pile.

Concrete was mixed in the proportions of one of cement, three of sand and five of gravel or broken stone for all mass work, and proportioned 1:2:4 respectively for building walls, beams, columns and for the top finish of the dam. Samples for testing were taken from every car of cement and all cement used was in conformity with the standard of the Engineering Institute of Canada.

With the exception of the mass work around the draft tubes and scroll cases in the power house, which was poured direct from the hoisting tower through chutes, the distribution of concrete was done in buggies and cars.

Throughout the length of the dam above the stop-log section, the concrete was conveyed in Hudson, steel, V-shaped, side-dump cars of 1 cu. yd. capacity. These operated on a track of 24-in. gauge laid on a light trestle built along



SPEED RING AND SCROLL CASE

the upstream side of the dam. The track had a slight downward grade away from the loading hopper. Turnouts were placed at short intervals.

During the cold weather the temperature of the concrete mixture was brought to a point which would ensure its reaching the forms before freezing, by heating the water used in mixing, also the sand and gravel. The latter was heated in the stock pile, steam pipes fitted with nozzles being introduced into the face of the pile and the whole covered with tarpaulins at night. As a further precaution against the concrete freezing after reaching the forms, these were thoroughly steamed before each lift of concrete was placed.

No Apparent Seepage

The concrete in the forebay walls and the dam was placed in sections 30 to 50 ft. in length. To key the adjoining sections, the bulkheads in between were provided with keystone-shaped boxes 12 inches deep, placed vertically for the full height of concrete. The number of boxes placed varied with the thickness of the section formed, the spacing generally being 3 ft. centre to centre. The junction between the various sections acted as an expansion joint and, in that portion of the spillway having a tunnel through it, these opened up during the cold weather. In order to prevent seepage through to the tunnel, these joints were caulked with oakum followed by cedar strips. The water has since risen, submerging the work, and from an inspection no seepage is apparent at these points.

Any water which may find entrance into the tunnel is taken care of by a drain emptying into a 10-in. tile pipe laid on the bed of the forebay and passing through the mass concrete at the power house into the tail race.

Forms were constructed of 1-in. dressed lumber, supported by 3 x 4-in. studding and waling. Studding was spaced 24 ins. and the waling 30 ins. centre to centre. The forms were held together by No. 20 gauge band iron, ¾-in. in width, placed at each spreader.

To resist the upward pressure of the concrete on the curved form of the downstream side of the spillway, these were securely wired to large stones embedded in the footing concrete.

The last section of the dam completed was about 30 ft. long and, being at a low point in the river bed, had served as an outlet for all the seepage through the cofferdam, unwatering the adjacent sections of dam. To close this, a cofferdam was quickly built across the opening and a box drain, sufficient in size to maintain the water at a level below the top of the cofferdam, was placed with the outlet below the dam. This was afterwards plugged and filled with grout.

Owing to the short period of time expected between the completion of the dam and the break-up of the ice in the river, the forms were left on the recently completed portion so as to protect, in a measure, the concrete from the ice. The stop-logs were left out at the sluiceways until after the break-up, and as these openings discharged the bulk of the flood and ice, the spillway was not submerged, with the exception of the section in the upper part of the rapids.

PLACING FORMS FOR DRAFT TUBES

Power House Construction

The power house is 71 by 66 ft., and provides for the installation of two units, with provisions for extending to enclose the remaining two units required to bring the plant to capacity. The transformer building is 37 by 101 ft. and forms a wing to the main building and both are under the one roof. The sub and superstructure walls, beams, columns, floors, roof and intake piers are of reinforced concrete construction. The intakes, scroll cases and draft tubes formed in the mass concrete of the substructure are heavily reinforced, also all air and cable ducts.

Considerable care was taken in the construction of the scroll cases and draft tubes and the cylindrical tapered forms for these were built very carefully in two sections, the bases of which corresponded to the horizontal plan in the scroll case and the vertical plan in the draft tube. The plan of the piece to be formed was marked out on a working platform on which sets of transverse frames were erected, accurately aligned, and covered with sheeting composed of narrow wooden strips used to facilitate bending and nailing to the required form. Nails were then countersunk and the work dressed to a smooth surface.

The draft tubes sections were swung into position with a derrick, securely fastened together, and the outlet brought to the proper line and level marked out on the downstream wall form. To prevent displacement by the upward pressure of the wet concrete, they were loaded with rock and securely wired to the rock foundation. The concrete was carried up to a point which cleared the bottom of the scroll cases. About this mass a ring of concrete was placed around the top of the draft tubes to support the speed ring, to which, after levelling and bolting, the scroll cases were attached and joined up to the intakes.

The superstructure walls are from 12 to 15 ins. thick, stiffened inside and outside by pilasters placed between the windows. The walls terminate at the roof in a parapet 8 ins. thick, capped with vitrified coping tile. The roof is a 4-in. reinforced slab, with 8 by 10-in. concrete purlins supported on steel trusses. This carries a false roof finished with five-ply tar and gravel roofing of Barret specification.

Quantities and Personnel

The major quantities involved in the construction were the removal of 21,000 cu. yds. of rock and 22,000 cu. yds. of other material in the preparation of the foundations of the dam and power house, also to provide suitable depth in the tail race and forebay. Concrete quantities amount to 23,350 cu. yds., the bulk of which was reinforced, 370,000 lbs. of reinforcing steel being used for this work. Structural steel used for roof supports, racks and stop-log guides amounted to 170,000 lbs.

The design and layout of all the work and the entire construction, were under the direct supervision of F. W. Teele, vice-president and chief engineer of the Southern Canada Power Co., Ltd. The work was performed by Morrow & Beatty, Ltd., engineering-contractors, of Peterborough, Ont.

CEMENT-CONCRETE BASE PROPORTIONS FOR BITUMINOUS PAVEMENTS

BY W. L. HEMPELMANN
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As the economic life of any permanent type of highway improvement is so dependent upon a satisfactory base, this very important matter is engaging the thought of many engineers and highway officials concerned with new improvements for future traffic conditions.

Snap judgment would suggest one of three methods to provide for the future's accepted, increased highway traffic: (1) a richer concrete base; (2) a thicker concrete base; (3) a richer and thicker concrete base. No one would advocate a base likely to fail under traffic such pavement may be called upon to carry. On the other hand, funds must not be wasted in the construction of a base which is too thick and rich.

As a result of extended personal observation and experience, most engineers recognize that rich concrete foundations crack more easily than the leaner mixtures. Foundations under bituminous pavements ten years old and older, of 1:3:6 or leaner concrete, laid without the care of present day practice, in general have been found to be practically free from serious cracks such as so frequently have been revealed in removing the bituminous wearing surfaces from 1:2:4 concrete bases three or four years old. In spite of expansion joints, and with every construction precaution to insure a dense, uniform pavement, concrete pavements of 1:2:4 or richer concrete, over five years old, show a larger number of serious cracks than are to be found in the leaner mix and less carefully prepared concrete foundations under bituminous pavements.

The importance of proper subgrade preparation and drainage need not be discussed here. Good engineering, however, would seem to dictate a policy of thicker concrete where necessary rather than increasing the richness of the concrete thoughout in an attempt to attain the same results. Improper subgrade conditions resulting in lack of uniformity in the support of the concrete base, will become more and more evident under the future fast-moving, heavy loads. Without proper support, any base—irrespective of mix and thickness—may and probably will fail.

With greater care in the preparation of the subgrade by thorough drainage and consolidation, there seems no reason for richer concrete base proportions; and conversely, unless these factors are recognized, anything but an unnecessary and wasteful thickness of the concrete foundation will be found inadequate and unsatisfactory.

With a view to determining the concensus of present opinion upon this important highway problem, letters were sent to the state highway departments and to many of the larger cities in the United States, enquiring about their practice.

The following is a tabulation of the replies received over the signatures of the proper officials of the states and cities. Some states failed to reply and others advised that this type of construction has not been used generally because of lack of funds.

States.		Cities	
Mix.	No. of Dept's Using Same.	Mix.	No. of Cities Using Same.
1:3:6	11	1:3:7	1
1:9	2	1:10	1
1:3:5	4	1:3:6	18
1:2½:5	8	1:3:5	3
1:2¼:4	1	1:2½:5	4
1:2:4	2	1:2:4	1

From the above it is evident that the 1:3:6 concrete is the generally accepted standard, and that the use of rich concrete base proportions would be in the nature of an expensive experiment not justified by experience.

The Engineer's Library

CONVEYANCE AND DISTRIBUTION OF WATER FOR WATER SUPPLY

Reviewed By Willis Chipman
Chipman & Power, Consulting Engineers, Toronto

By **Edward Wegmann.**—Published by the D. Van Nostrand Co., New York; 663 pages, 367 illustrations, 8 plates; 6¼ by 9¼ ins.; cloth; price, $5 net.

This is the first practical treatise on water works that has appeared for some years, in the United States at least. In chapter I. the consumption of water in American cities is analyzed, and statements given of consumption in European cities, showing conclusively the unnecessary waste that prevails in America. The table of hourly fluctuations will be found of interest.

Chapters II. and III. deal with flow of water in aqueducts and through pipes, and contain some practical applications.

In the chapters on construction, which comprise Part 2, chapter IV. gives valuable information respecting wood-stave pipe, which has been used so extensively in the west. The chapters that follow (V., cast iron pipe; VI., wrought iron and steel pipes; VII., pipes of vitrified stone ware, cement and concrete) will be found of interest.

Chapter VIII., on stresses. is valuable, but might have been expanded to refer to cases of backfilling in soft materials, drawing of sheeting and impact from earth falling from trenching machine buckets.

Chapter IX., flexible joints; chapter X., submerged pipes; chapter XI., gates and valves; and chapter XII., hydrants, contain illustrations and descriptions of standard materials.

In chapter XIII. the intakes and tunnels in many cities in the United States are illustrated, but no reference is made to the hundreds of intakes laid under varying conditions for small towns.

Chapters XIV. and XV., on aqueducts, are of historical interest, and also contain descriptions of the New Croton Aqueduct, the Catskill Aqueduct, the Boston Aqueduct, the Los Angeles Aqueduct, the Coolgardie Pipe-Line, etc.

Service reservoirs are considered in chapter XVI.; and in chapter XVII., reinforced concrete standpipes are described.

Tanks of wood and of steel, and trestles for supporting them, are illustrated and described in chapter XVIII.

Fire protection from fire hydrants (chapter XIX.) and chapter XX. on high pressure water systems are valuable, up-to-date additions to our water works literature. The last chapter (XXI.) in part 2, on distribution systems, disposes of a most complex problem in a few pages.

Part 3, comprises chapters XXII. to XXXII. inclusive, devoted to maintenance and operation.

Chapter XXII. covers service pipes and connections; chapter XXIII., cleaning aqueducts and mains by machines; chapter XXIV., thawing pipes and hydrants. Montreal, Winnipeg and other Canadian cities could furnish interesting examples of additional appliances used for thawing services, hydrants and mains.

Chapter XXV. is devoted to leakage, and might have been greatly expanded with advantage to the water works superintendent.

The durability of mains of different materials is discussed in chapter XXVI., but no reference is made to service pipes and fittings.

Electrolysis is briefly treated in chapter XXVII., and various tools and appliances are described in chapter XXVIII.

In chapters XXIX. and XXX., the prevention of waste is discussed, all too briefly. These chapters are followed by XXXI. on water meters, in which various types are well described and illustrated. There is, however, no mention made of loss of head in meters at different capacities, an important matter in compound meters.

Chapter XXXII., recording instruments, describes standard devices. There has yet to be perfected an automatic apparatus that can be depended upon during extreme cold weather to indicate to a pump-house engineer when a distant tank or reservoir is at the point of overflow.

The standard specification for cast-iron pipes and special castings, of the American Water Works Association, is given as appendix I., and for hydrants and valves in appendix II., and specification for structural steel in appendix III. Appendix IV., automatic sprinklers, which might have appeared as a separate chapter, concisely describes standard practice. In appendix V., fire streams, are incorporated standard tables of flow of hose streams.

This book may not contain everything that the waterworks superintendent desires to know, but in it he will find much information of practical use.

PUBLICATIONS RECEIVED

A History of Chemistry.—By F. J. Moore. Published by the McGraw-Hill Book Co., Inc., New York City. First edition, 1918; 292 pages and cover; illustrated; 5½ by 8 ins.; cloth; price, $2.50 net.

British Columbia Public Works Department.—Report for the fiscal year 1917-8; 140 pp. and cover, 7½ by 10½ ins. Issued by J. H. King, Minister of Public Works, Victoria, B.C., Includes the reports of A. E. Foreman, public works engineer; Henry Whittaker, supervising architect; John Peck, chief inspector of machinery; D. P. Roberts, inspector of electrical energy; etc.

COST OF PUMPING THROUGH PIPE LINES*

By G. C. Habermeyer
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Many municipalities secure water for a public supply some distance from the municipality. In a few places water flows from the source to the municipality by gravity, but in nearly all installations in this state it is necessary to pump through a pipe line. Water may be delivered directly to consumers or to a reservoir from which it is pumped or flows by gravity to consumers. The choice of a proper-sized pipe line is of considerable importance. Where reservoir capacity is not provided, pump and pipe-line capacity should be sufficient to meet maximum demands. Occasionally high demand may be met in some installations by increasing pressure to correspond to increased friction losses in pipe line, or if water at low pressure will satisfy the extra demand, by allowing pressure at points of consumption to drop.

In choosing a pipe line for any certain installation, it is common to consider the economical velocity of flow through the pipe. This may be of considerable advantage, but it is probable that only on rare occasions will water flow at such velocity. The loss of pressure in various sized pipes carrying water at a given rate of flow is often computed and the extra cost of pumping in the smaller pipes balanced against the extra first cost of the larger pipes.

*Read March 26th before the Illinois Section, American Water Works Association.

Officials in charge of the installation of or changes in a water supply would do well to consider the entire cost of pumping through the pipe line reduced to cents per thousand gallons (or other unit by which water is sold). In some installations, knowing the comparatively low cost, more consideration would be given to securing a water of excellent quality at some distance, possibly from another public supply. In other instances the advantage of providing reservoir capacity to reduce fluctuations in rate of flow, or of providing good service with large sized pipe, could be more readily shown.

In many cities one of the greatest difficulties in installing a public water supply is to secure active co-operation for the support of one definite project. Intelligent citizens in two small cities have been found to favor taking water from Lake Michigan more than 200 miles away. Figures on cost of pipe and pumping, estimating that with aid of other cities the water could be conveyed the first 150 miles at practically no cost, would have been rather easy to secure and would probably have convinced these people at once that another supply was preferable.

The life of a pipe line carrying water such as is in general use for public supplies is not generally affected by the velocity of flow within ordinary ranges. Therefore, to double the rate of flow divides by two the interest and depreciation change per gallon. However, with increased rate of flow the friction increases; and with same pipe line, same cost of pumping 1,000,000 gallons one foot high, and not including interest and depreciation on pipe line, increasing the flow 50 per cent. multiplies the total cost of pumping by three.

Cost (in Dollars) per Mile per Million U.S. Gallons of Pumping Water at Various Rates Through Different Sizes of Cast-Iron Pipe Lines

Diameter of Pipe

Gallons a day	6 Ins. Operation	6 Ins. 6% of pipe line cost	6 Ins. Total	8 Ins. Operation	8 Ins. 6% of pipe line cost	8 Ins. Total	10 Ins. Operation	10 Ins. 6% of pipe line cost	10 Ins. Total	12 Ins. Operation	12 Ins. 6% of pipe line cost	12 Ins. Total
100,000	.42	6.92	7.34	.11	9.12	9.23						
150,000	.86	4.62	5.48	.22	6.08	6.30						
200,000	1.43	3.47	4.90	.36	4.56	4.92	.13	6.08	6.21	.05	7.81	7.86
250,000	2.11	2.77	4.88	.53	3.64	4.17	.18	4.84	5.02	.08	6.25	6.33
300,000	2.90	2.31	5.21	.73	3.03	3.76	.26	4.04	4.30	.11	5.21	5.32
400,000	4.80	1.73	6.53	1.21	2.27	3.48	.42	3.04	3.46	.18	3.90	4.08
500,000	7.10	1.39	8.49	1.78	1.82	3.60	.62	2.42	2.84	.27	3.12	3.39
600,000	9.77	1.15	10.92	2.46	1.52	3.98	.86	2.02	2.88	.36	2.60	2.96
800,000	16.15	.86	17.01	4.06	1.13	5.19	1.42	1.52	2.94	.60	1.95	2.55
1,000,000				6.00	.91	6.91	2.10	1.21	3.31	.89	1.56	2.45
1,200,000				8.26	.76	9.02	2.89	1.01	3.90	1.23	1.30	2.53
1,400,000							3.78	.87	4.65	1.61	1.11	2.72
1,600,000							4.77	.76	5.53	2.04	.97	3.01
2,000,000										3.01	.78	3.79
2,400,000										4.13	.65	4.78

Diameter of Pipe

Gallons a day	14 Ins. Operation	14 Ins. 6% of pipe line cost	14 Ins. Total	16 Ins. Operation	16 Ins. 6% of pipe line cost	16 Ins. Total	20 Ins. Occupation	20 Ins. 6% of pipe line cost	20 Ins. Total	24 Ins. Operation	24 Ins. 6% of pipe line cost	24 Ins. Total
300,000	.05	6.22	6.27									
400,000	.09	4.66	4.75									
500,000	.13	3.72	3.85	.07	4.50	4.57						
600,000	.18	3.11	3.29	.09	3.75	3.84						
800,000'	.29	2.33	2.62	.15	2.81	2.96	.05	3.90	3.95			
1,000,000	.43	1.87	2.30	.23	2.25	2.48	.08	3.12	3.20			
1,200,000	.59	1.55	2.14	.31	1.88	2.19	.11	2.60	2.71	.04	3.39	3.43
1,400,000	.78	1.33	2.11	.41	1.61	2.02	.14	2.23	2.37	.05	2.90	2.96
1,600,000	.98	1.16	2.14	.52	1.40	1.92	.18	1.95	2.13	.08	2.54	2.62
2,000,000	1.45	.94	2.32	.76	1.13	1.89	.25	1.56	1.81	.11	2.04	2.15
2,400,000	1.99	.77	2.76	1.05	.94	1.99	.36	1.30	1.66	.15	1.70	1.85
2,800,000	2.60	.66	3.26	1.37	.80	2.17	.48	1.11	1.59	.20	1.45	1.65
3,200,000	3.29	.58	3.87	1.74	.70	2.44	.60	.98	1.58	.25	1.27	1.52
3,600,000	4.03	.52	4.55	2.13	.63	2.76	.74	.87	1.61	.31	1.13	1.44
4,000,000				2.56	.56	3.12	.89	.78	1.67	.37	1.02	1.39
5,000,000				3.80	.45	4.25	1.32	.62	1.94	.55	.82	1.37
6,000,000							1.81	.52	2.33	.76	.68	1.44
8,000,000							3.00	.39	3.39	1.25	.51	1.76
10,000,000										1.86	.41	2.27
12,000,000										2.56	.34	2.90

See article for assumptions re friction, cost of pipe, etc.

A pipe line built without regard to increased demand in future may result in very high pumping costs or building of another line in the near future. A line built to give economical cost of pumping ten or twenty years in the future, may be very expensive on account of high interest charged on the investment. Since in many instances it is necessary to vary the rate of pumping throughout the day, the size of pipes should be so chosen that average cost will be economical. It may be economical in some cases to pump at a definite rate for several hours each day until sufficient water is pumped to meet the demand for the entire day. Interest and depreciation continue, however, when line is not in use.

Knowing definitely the cost units, the cost may be shown best by curves, but for a basis from which to draw curves for any cost units, values are best shown by tables.

The accompanying table is prepared to show cost of delivering water at uniform rates of flow through pipe lines. The pumping cost is taken at ten cents per million gallons, one foot high. Friction is computed by the formula of Flamant as given by diagram in "Public Water Supplies," by Turneaure and Russell. The cost of pipe is taken at $30 per ton for class B cast-iron pipe, and interest plus depreciation on the pipe line is taken at 6%.

When pumping costs are low, pumping a little above the most economical rate does not greatly increase the total cost per million gallons. However, by choosing the next larger sized pipe, the cost could, in many cases, be greatly decreased.

Costs for pumping part time at uniform rate may be computed from the table. For example, pumping through a 10-inch pipe line at a rate of one million gallons a day, an average of eight hours a day, the cost of pipe line per million gallons would be three times that given in the table, or $3.63. Operation if cost is 10 cents per million gallons 1 foot high, would be $2.10 as given,—total $5.63. Pumping for eight hours at a rate of 500,000 gallons a day and for 16 hours at a rate of 1,000,000 gallons a day, the cost would be 1/6 of a million at $2.84=47 cents, plus 2/3 of a million at $3.31=$2.20; a total of 833,000 gallons at a cost of $2.67, or $3.20 per million gallons.

For various unit costs of pumping, corrections may readily be made. For cost of pipe delivered to station within one or two miles of construction work other than $30 per ton, the cost may be closely approximated by varying the cost on the pipe line and the 6% on investment proportionately, as the cost of iron is a large part of the cost and generally when pipe is high, labor is also high. Actual cost of pipe line chosen for table may readily be found, as 6% of the cost is given.

Cost of pumping as affected by differences in elevation, uncertainty of future demands and many other problems to be considered in waterworks installation are not considered in this paper.

At a recent meeting of the Associated Boards of Trade of Ontario, a resolution was passed recommending that the Department of Railways and Canals should begin work at an early date on plans and surveys for the construction of a canal and river system from Lake Ontario to Montreal of capacity equal to that of the new Welland canal. Other resolutions called for the extension of the T. & N.O. Railway from North Bay to Parry Sound and for the early beginning by the Dominion Government of work on the French River development as the start of the Georgian Bay canal system.

Hon. N. W. Rowell states that no announcement will be made regarding the personnel of the new Federal Department of Public Health until after Sir Robert Borden's return to Canada. During the discussion in the House of Commons of the bill creating the new department, Capt. (Dr.) Manion asked that the minister in charge of the department should not be a medical man, claiming that as a doctor he could say that the ordinary medical man has very little knowledge of public health. The object of the new department was stated broadly in the preamble to the bill to be the "social welfare" of the people.

INSTALLATION, CARE AND MAINTENANCE OF WATER WHEELS

By D. W. Rounds
S. Morgan Smith Co., York, Pa.

Incidentally the writer will preface this paper by saying that he has had to do, as erector, with a greater number of water wheels than has any other man in the United States, hence has accumulated a varied fund of experience from the mechanic's point of view; also, obviously, from the engineering and design viewpoint.

The proof of a water wheel is its operation, and only by their records in operation can we improve water wheels or any other machines.

In the crucial test of any water turbine unit, the valves or gates stand out as the most important feature, not excepting the runner itself. This fact is gradually dawning upon us as the demand for speed regulation becomes more exacting. Some time, not far distant, as we improve the wheel gates, we will actuate them by an all-electric apparatus, discarding the hydraulic governor entirely. This is both economical and entirely feasible.

Must Have Straight Shaft

In erecting, we must ever have in mind that the shaft coupling is a weak place, a spot where any error will become apparent. There are often errors in alignment, or what is more frequently encountered if it be a cast coupling or one keyed on the shaft, is the imperfect fitting of the key, so that in driving it distorts the coupling. To show maximum power on the switchboard, we must have a straight shaft. A shaft will run equally well at any angle between the level or vertical, provided it is straight. We set shafts vertically or horizontally because we have instruments designed for these two positions.

In setting a vertical water wheel, suspend it by its thrust bearing and, if coupled properly, the shaft will assume the vertical position more accurately than by any other method and without instruments and with no possibility of error. This method is applicable to any size, large or small.

In the popular mind, the electrical part of a unit can do no wrong. The water wheel can, and is looked upon as an anarchist, a disturber of peace and the source of all our earthly woe. Perhaps this is true, but there are others.

An excessive end thrust is developed in a horizontal shaft. It is apparent in the thrust bearing, so is chargeable to the water wheels, but with careful analysis it is seldom found there. More often it is found in the relative position of the rotor to its armature. Again, a slight "wabble" may be observed in a vertical shaft. It is apt to increase with time. This may be traced to an unbalanced condition electrically, or to the fact that the rotor is not in running balance although it may be in static balance.

Careless Inspection Causes Trouble

In one feature, at least, the water wheel stands prominently alone; it is in a class by itself in that it inspires in the mind of the operator that it needs no attention till it breaks. No other machine on earth or under the earth, receives so little care as the water wheel. Perhaps the engineers are responsible for this neglect, as they insist that water wheels shall be installed in wet places. No other machines are put there. But despite these disagreeable surroundings, the water wheel is inspected regularly. The reports show that the flume is opened and that a lantern and a man's head have been thrust in. Perhaps the man himself gets through the hole, looks about in the darkness of the slimy, noisome place, assures himself that the water wheel is really there, and reports accordingly. Later something happens; confusion reigns as the power goes off. Surely the water wheel was in good order; report shows that everything was screwed up tight; so the burden is shifted to the manufacturer.

The erector need not necessarily be a mechanic, but at all times and in all ways he must be a diplomat, for he is ever between the devil and the deep sea. Great, paternal governments provide sanctuary for all creatures, including the beasts of the field and the fowls of the air, but make no mention of the erector. The erector must not have an opinion nor even think; or what he thinks, he must not speak, and what he speaks he must not think. If errors become apparent in the shop work, he must assume the burden personally and protect the shop. It is bad form to criticise before strangers one's source of revenue, always remembering that if you get your salary, you must first help your employer to get it.

An Unnecessary Shut-Down

In the course of travel covering eastern Canada and the United States, I note the almost entire neglect of the water wheel. Of course the reason is obvious; but for all that, it is vitally necessary that water wheels should be kept in good condition, not simply inspected, but possible failures anticipated and prevented.

Recently I repaired a hydro unit and found a pedestal bearing (water bearing) which had chafed down into its cement base for five-eighths of an inch, resulting in a broken shaft and runners and a shut-down for four months. This could easily have been avoided if carefully inspected and repaired.

Too many look upon a water wheel simply as a shaft sticking out of the water, and avoid investigating the lower end; let it run as long as it will, seems to be the slogan. This imposes an uunecessary burden upon the manufacturers and seriously reduces the production of the plant. In the interests of the country at large, the water wheel is a vital factor; that it may be rescued from this superstitious horror that now surrounds it, let us know that the wheel is a machine that has parts, bolts, nuts and screws, and that must be watched like a steam engine, for it is an engine.

CHLORINATION OF SEWAGE*

Tests at New Haven on Crude and Screened Sewage and the Effluents from Imhoff Tank and Activated Sludge Process

IN the experiments on sewage disposal conducted last year in New Haven, Conn., tests were made of the use of chlorine in reducing the bacterial content of crude sewage and plant effluents. "The effluents from the screen chamber, the Imhoff tank and the activated sludge process were conducted by wooden flumes to small baffled tanks giving detention periods of from two to five minutes, where they were chlorinated. The chlorine was applied in the form of liquid chlorine delivered from a Wallace and Tiernan solution-feed apparatus, designed for these experiments, with three solution jars and volumetric meters. The chlorinated samples were held in the sample bottles for 30 minutes before plating to reproduce the action of the small storage tanks that would be required in an operating plant."

Twenty-Seven Tests on Crude

Twenty-seven tests were made in the application of chlorine to crude sewage, the amounts of chlorine varying from three to eight parts per million. Averaging the several tests, it was found that with three parts per million the total bacteria were reduced 87 per cent. and the B. coli 55 per cent. With five parts, the total bacteria were reduced 96 per cent. and the B. coli 99 per cent., while with eight parts, the total bacteria were reduced 99 per cent. and the B. coli 94 per cent. (No explanation is offered of the lessened effectiveness of the chlorine in reducing B. coli with an increase in the dose.)

Testing screened sewage, it was found that, with three parts of chlorine per million, the total bacteria were reduced 88 per cent. and the B. coli 48 per cent.; with five parts the reductions were 99 per cent. and 97 per cent., respectively; and with seven parts per million both total bacteria and B. coli were reduced 99 per cent.

In treating Imhoff effluent, the results obtained with three parts per million were 99 per cent. and 65 per cent., respectively, while with six parts per million the reduction was 76 per cent. and 84 per cent., respectively. "The unstable organic bodies which result from septic action tend to use up a considerable portion of the chlorine before it can act on the bacteria," and this probably accounts for the less effectiveness of these tests with Imhoff effluent, and possibly for the irregularity also.

"The effluent from activated sludge treatment is particularly amenable to further purification by the use of chlorine, since its original bacterial content should be already reduced, and since its free oxygenated condition leaves the chlorine free to exert a maximum disinfection action. The activated sludge process, operated as we operated it, with a minimum degree of aeration, and acting on the abnormal East Street sewage, yielded only a moderately purified effluent." With an addition of two parts of chlorine the total bacteria were reduced 78 per cent. and the B. coli 88 per cent. In the three samples tested with three parts of chlorine, the activated sludge process had already reduced the number of B. coli 73 per cent. and no further reduction was effected by the use of chlorine.

Summing up their conclusions in regard to chlorine treatment of sewage, Professor Winslow and F. W. Mohlman, the chemist of the experiment station, report as follows:—

Conclusions Regarding Chlorination

"It appears evident that three parts of chlorine will yield fairly satisfactory results with the effluent of the activated sludge process; that seven or eight parts are needed for crude sewage; that five parts will probably suffice for screened sewage; and that, so far as the Imhoff effluent is concerned, six parts will not give satisfactory results as to total bacteria, but may yield an effluent which is low in colon bacilli.

"In making our estimates as to the cost of chlorination combined respectively with fine screening and with Imhoff treatment, we have assumed, in the absence of more conclusive data, that five parts of chlorine will produce a satisfactory degree of purification in both instances, basing this assumption chiefly on the results of the colon tests, which are of much more practical moment than the counts of total bacteria. It is evident, however, that this amount may very possibly have to be increased in practice, particularly in the case of the Imhoff effluent."

The cost of chlorination in each case is estimated at $4.05 per million U.S. gallons.

*From "Municipal Journal and Public Works," New York City.

The Graves bill has been passed by the New York Legislature, appropriating $3,000 for the expenses of a committee which will work with a Canadian committee to bring about the construction of a peace memorial bridge across the Niagara River. It is said that the money will be spent in publicity work with the idea of cultivating sentiment in New York State in favor of the proposed structure.

The annual meeting of the Engineers' Club of Peterborough, Ont., was held April 12th, and the following officers elected for the ensuing year:—Hon. president, C. E. Canfield; president, G. R. Munro, of the William Hamilton Co.; vice-president, R. H. Parsons, city engineer; secretary-treasurer, R. L. Dobbin, water works superintendent; directors, R. B. Rogers, P. L. Allison, H. O. Fisk, E. R. Shirley, James Mackintosh and G. R. Langely. The meeting was addressed by Secretary Keith of the Engineering Institute of Canada, who discussed the possibility of organizing a Peterborough branch of the institute. A committee was appointed to report upon the advisability of organizing such a branch. There are about fifteen corporate members of the institute in Peterborough and others have signified their intention of joining.

THE NECESSITY OF FILTRATION*

Why Cities and Towns Should Filter Their Water—Economic Consideration Apparently Most Difficult of Comprehension—Heavy Typhoid List

By F. B. Leopold
General Manager, Pittsburg Filter Mfg. Co.

RECENTLY I received two letters from engineers in widely separated sections, each requesting similar information as to the possibility of purifying the water supply of their cities, in each case referring to a stream better than the average in its natural condition. If in this day, with the fund of available information at hand, and with over seven hundred municipal filtration plants in operation, there are still engineers who question the possibility of purification of water supplies, we must then continue to give the "Why's" and reiterate them over and over again until the fullest measure of protection in our water supplies is attained.

When the necessity of building camps for the concentration of large bodies of our young men, for training them into soldiers for our great army became apparent, the first consideration in their location was the water supply. The best experts were sent to the various locations to investigate the available sources and means of purifying them. Our authorities recognized that the first necessity to consider was health, and that pure water was the essential thing to this requirement. Water purification plants were installed and placed in operation either directly or from cities already having them established.

First Essential of Army

Filter plants and portable purifying plants were sent to France at the earliest possible date to care for the requirements of the army on the other side. Why? Because the greatest protection to a healthy body and efficient work is pure water. In every movement of the army, the water was of the first consideration, as essential as food, guns and ammunition. Is this not a lesson that all civilians should learn if they have not already done so?

To one of ethical taste, clear sparkling water to drink or in which to bathe, is a source of pleasure and joy. Sentimentally, the protection of family and friends from water-borne disease germs is a strong argument that appeals to those individuals that know the dangers from this source. There are thousands who have had it brought home to their own fireside, and with the histories of the great decrease in typhoid in Pittsburgh, Philadelphia, Cincinnati and hundreds of smaller cities available for the asking, there is no excuse for lack of knowledge.

From a Community Standpoint

But the great "Why," from a community standpoint, is the economic consideration, and this is the point that seems most difficult of apprehension: unless the individual is affected by direct contact he is still largely blind to the fact that what affects economically the community in which he lives, affects him personally.

Heavy Typhoid Casualty List

We, as a nation, for a long time failed to see that the world war in Europe concerned us, yet it did vitally, just as much in the first two years as the last year when we did wake up to a realization of its meaning to us as a community if we contented ourselves to look on. We went out to set things right, yet our annual death and sick list from typhoid for many years has nearly equalled the death and casualty list suffered in this war. G. A. Johnson, in his most valuable paper, gives the annual number of sufferers from this disease as 300,000 with an annual death rate of 20,000. (The death rate has been as high as 50,000 in a single year.) This means an economic loss of $150,000,000 and every community is paying a certain portion of this sum, and even those that have means to protect themselves, nevertheless suffer by reason of the laxity of others.

The installation of purification plants has shown an economic saving in many communities that in from two to five years has paid the cost of such installation. In other words, they have shown a profit on the investment of from 20 to 50 per cent., and this is a continuous profit once instituted. Can you beat it? When we are fully awake to the meaning of this, all communities will get busy just as they have in this war, and will have a better and safer place to live in.

We can have pure water if we want it and go after it. There is no reason for incredulity. It is a simple engineering problem, that requires only competent advice and the expenditure of a reasonable amount of money, but there are hundreds of communities still paying the price of inexcusable ignorance or neglect.

*From "Fire and Water Engineering," New York.

LICENSING WATER PLANT OPERATORS

Water Purification and Sewage Treatment Plants Should be Operated by Licensed Attendants

By L. G. Denis
Hydro-Electric Engineer, Commission of Conservation

MOST citizens do not fully appreciate the high degree of responsibility that rests on the operators of water purification plants. These operators have in their hands the lives of the population served practically to the same degree as a locomotive driver, and more so than a boiler stoker. Why not have them also licensed? Pioneer legislation along these lines has been enacted by the state of New Jersey, the bill providing that hereafter all sewage treatment plants must be in charge of superintendents or operators licensed by the state. On its introduction in the legislature, the bill was accompanied by a statement of its purpose which is well worth quoting: "The purpose of this bill is to secure the employment of attendants at water-purification and sewage-treatment plants having a higher degree of intelligence and more familiarity with the operation of these plants than is now the case. There are a large number of water-purification plants and sewage-disposal plants now in operation in this state. The experience of the State Department of Health has shown that many of these plants, particularly the smaller ones, are operated in a very unsatisfactory manner. This results, in the case of water-purification plants, in imperfect purification of the water at times, and the consequent exposure, of the people who use the water, to danger from water-borne disease. The unskillful and careless operation of these plants also results in their rapid deterioration, which ultimately entails upon the municipalities owning them the expenditure of funds for repairs and replacements which would not be necessary were the plants properly operated."—From "Conservation," the monthly published by the Commission of Conservation.

A reader desires to secure a copy of *The Canadian Engineer* for December 26th, 1918. Subscribers who have a copy of that number that they do not intend to bind, are requested to be kind enough to inform the circulation manager, 62 Church St., Toronto. Payment will gladly be made for the copy if desired.

The citizens of Wallaceburg, Ont., are advocating the erection of elevators there to store the grain previous to shipping it over the Pere Marquette and the proposed "Hydro" radials. "When the Pere Marquette is electrified," says Sir Adam Beck, "and when it forms an integral part of the Hydro radial system of the province, if the municipalities concerned still want these developments undertaken, there is no reason why they should not go ahead with them." The Wallaceburg proposals include a winter harbor for the grain boats.

SUFFICIENT POWER FOR TWENTY CITIES*

Southern British Columbia is said to be Rich in Important Water Powers

By James White
Deputy Head, Commission of Conservation

IN British Columbia, there are many important water-powers. The investigation of the water-powers of British Columbia by the Commission of Conservation has disclosed the existence of two great water-power centres, namely, Nelson, with 400,000 h.p. within a radius of 50 miles, and Vancouver, with 300,000 h.p. within the same distance. Based on experience at Toronto, these quantities would suffice for a population of 1,700,000 at Nelson, or for 10 manufacturing cities of 170,000 each. The power near Vancouver would suffice for one manufacturing city of 1,250,000 population, or for 10 cities of 125,000 each.

There are 12 power-sites in British Columbia of 50,000 h.p. and upwards. With the exception of the South fork Quesnel and Peace rivers, all these powers are less than 125 miles from the 49th parallel.

	Horse-power
Kootenay River, Upper and Lower Bonnington Falls, possible development	125,000
Pend d'Oreille River, Waneta	73,000
Pend d'Oreille River, Salmon River	50,000
†Thompson River	100,000
†Fraser River Hellgate	200,000
Bridge River tunnel	70,000
Stave River, lower site	52,000
Stave River, upper site	52,000
Coquitlam-Buntzen, North arm Burrard Inlet	84,000
Campbell River, possible	100,000
South fork Quesnel River	90,000
Peace River canyon	100,000

There are 18 power sites of between 20,000 and 50,000 h.p. Eight of these sites are distant less than 100 miles from the 49th parallel.

Kootenay River, Cora Lynn to Granite Rapids	22,000
Kootenay River, rapids near mouth	22,000
Pend d'Oreille River, Nine-mile Falls	32,000
Pend d'Oreille River, Fifteen-mile Creek	34,000
Columbia River, Long Rapids	30,000
Adams River	30,000
Barrière River, ultimate development	20,000
Murtle River, Helmcken Falls	20,000
Nahatlatch River, rapids below lakes	30,000
Jones Lake (Fraser River)	25,000
Jordan River (25,000 h.p. developed), ultimate	38,000
Cheakamus River, Bear Mount Canyon	40,000
Powell River (24,000 h.p. developed), ultimate 32,000—	35,000
Nechako River, Grand Canyon	30,000
Nechako River, Tetachuck Falls and rapids	30,000
Bulkley River, Hagwilget Canyon	20,000
Nass River, falls below Cranberry River	20,000
Nass River, rapids and falls below White River	20,000

There are 29 power sites of between 10,000 and 20,000 h.p. capacity and 585 of less than 10,000 h.p. The report of the Commission of Conservation on the *Water Powers of British Columbia* includes all available data respecting 644 water-power sites.

*From "Conservation."
†Development debarred owing to presence of railways.

The Greater Winnipeg Water District may go into the sand and gravel business to supply the city of Winnipeg and the other municipalities that were associated with the city in the Shoal Lake Water scheme. It is thought that the board will be able to sell sand and gravel for paving and other purposes at lower rates than are now being paid to private contractors.

ILLOGICAL TESTS OF INTELLIGENCE

By Halbert P. Gillette
Editor, "Engineering and Contracting," Chicago

PROF. James, in his "Talks to Teachers on Psychology," began by warning against certain fads and fancies, the pseudo-psychology of his day. There are always numbers of men who seize upon and exploit for their own profit every new science. Usually they are not in the least bit scientific themselves, but they ape the ways and the words of scientists so skilfully that they are often able to pass for men of learning. During the past decade we have seen and heard a host of such mimics—pseudomorphs, they would be called were they minerals—who have termed themselves "efficiency engineers." Men who were neither engineers nor efficient, who could not even properly define science, efficiency or engineering, have been posing as "fathers" and "pioneers" of the science of management. Small wonder that they have almost brought "efficiency engineering" and "scientific management" into disrepute.

"Scientific Management" and Charlatanism

Applied psychology is a new science that seems fated to pass through a period of charlatanism analogous to the period from which "scientific management" is just emerging. "Epoch making" books on Character Reading, Will Power, Memorizing, etc., are being widely advertised. The advertisements alone should suffice to put a thinking man upon his guard, so extravagant are the claims; but most men, even among the so-called educated classes, are not trained to think, and are therefore easily taken in by specious argument and spacious assertion.

During the last 12 years more than 2,000 books on business matters have been published in the English language. These were preceded by countless articles on management, accounting, "system," etc., etc. We are now beginning to see so many articles on applied psychology that it will not be surprising if 2,000 books on the subject appear within the next decade. Engineers can no more afford to ignore the current literature on applied psychology than that on scientific management. But if they wish to conserve their time they must learn how to discriminate between the good and the worthless. As a first step in acquiring a faculty of discrimination, it is well to study at least one or two books on logic, such as Bains or Jevons. The next step should be to adopt a suggestion that Molesworth made about "engineers' pocketbooks"—write your own. In short, analyze the reasoning methods used by others as well as by yourself.

Cannot Add Different Units

An engineer, being trained to use mathematics, knows that before he can calculate the combined effect of different energies, he must reduce them to a common unit. He knows that 100 horse-power can be added to 10 British thermal units per second, only by converting H.P. to B.T.U. per sec., or vice versa. An engineer knows that 100 H.P. plus 10 B.T.U. per sec. does not make 110 units of any kind whatsoever. Yet the same engineer will probably read without criticism an article in which a military officer is "rated" thus:—

Physical qualities	9
Intelligence	12
Leadership	15
Personal qualities	9
General value to the service	22
Total rating in scale of 100	67

Ask yourself how it is possible to add 9 units relating to "physical qualities" to 12 units relating to "intelligence." Stop right there. Do not let yourself be confused by the use of "units" to which you are unaccustomed. Remember that you can not add a per cent. of a full barrel of cement to a per cent. of a full car load of sand, and get a per cent. of anything in particular. Consider, then, that you can not add physical qualities to mental qualities, any more than you can add the hardness of quartz (in the scale of mineral hardness) to the height of a mountain.

Mann Report Sadly Marred

In 1917, I pointed out that Prof. C. R. Mann's report on the study of engineering education was sadly marred by the fallacy of rating incommensurables in an alleged order of importance. Nearly 6,800 inquiry cards were filled in and returned by engineers, giving the "order of importance in judging the reasons for engineering success." In analyzing "the most probable values of the relative importance of these groups of qualities," Prof. Mann applied a method given in Thorndike's "Theory of Mental and Social Measurements," with the following result as deduced from the answers of 5,441 engineers:—

Character	24.0
Judgment	19.5
Efficiency, industry, etc.	16.5
Understanding of men	15.0
Knowledge of fundamentals of engineering science	15.0
Technique of practice	10.0
Total	100.0

I need not repeat my original criticism of the false logic involved in such an application of mathematics. But it may be well again to emphasize the significance of the fact that so many engineers were led to attempt to do the impossible when they assigned an "order of importance" to the six "qualities" above named. What is the relative importance of the heart and the brain? Ask such a question of any man and he will think you are jesting. But merely change your question a trifle, and he receives it in seriousness. What is the relative importance of character and knowledge, asks Prof. Mann, and nine out of ten engineers answer by placing character ahead of knowledge. We need not look long for the reason that led to this rating. Character is mainly inherited and only partly acquired. Knowledge is entirely acquired. Since what comes first in order of time is apt to be regarded as first in order of importance, character is apt to be given preference over knowledge in answering a question as to their relative importance. However, the question was not intended to establish a rating based on any order of appearance of the qualities named; it was intended to ascertain the relative importance of all the qualities at any given time—simultaneously. Here is a man with a given character and a certain fund of acquired knowledge. Compare him with other men both as to character and knowledge, and state his relative standing. My answer is it can not be done by adding together incommensurable units.

"Values" that are Fallacies

Where two kinds of energy combine to produce a given result, neither one can be rated above the other; both are essential. But it may be possible to express both kinds of energy in the same unit, and then rate them quantitatively. Thus, two chemical elements may unite if a certain amount of heat is applied to them. The two chemicals and the heat are equally essential to produce the reaction or effect. But the number of thermal units ascribable to each of the two elements may be ascertained, and their relative contribution to the total heat of combination may be calculated. Some such calculation of the relative number of mental units in "character" and in "knowledge" may possibly be made by psychologists a century hence, but not until that is accomplished will it be rational to rate "character" at 24 and "knowledge" at 15, as was done by Prof. Mann. Any such rating is really nonsense, and it stands on all fours with the psychological rating of army officers above referred to.

Radical Experiment at Columbia

In Prof. Lewis M. Terman's book on "The Measurement of Intelligence" the claim is made that the best single test of intelligence is the "vocabulary test." It is claimed to give results approximating those obtained by applying the Binet-Simon psychological tests. This may be true, but if the Binet-Simon tests are not satisfactory, the vocabulary tests can not be more so.

It is evident that a vocabulary test will indicate, to a considerable extent, the tenacity of memory and the range of reading, and the habit of defining words. All these are indicative of mental power, but there is vastly more to "intelligence" than these three factors.

I do not wish to convey the impression that I am opposed to psychological tests. What I am opposing is the extreme claims that are being made for these short-cut methods of "sizing up" men. In doing so I have incidentally pointed out one of the gravest of fallacies, namely the assigning of quantitative values to incommensurable qualities, and then using these quantities as if they related to common units of measure. I have yet to see a rational defense of such a procedure.

Columbia College, it has been announced, is about to adopt psychological tests and abandon ordinary examinations for entrance. To put it mildly, this is a radical experiment. It may prove to possess merit, but I venture to predict that psychological tests alone will not suffice in selecting the fittest applicants for admission to college.

Letter to the Editor

CARRYING CAPACITY OF STEEL PIPE

Sir,—The enclosed brief report on the carrying capacity of a water supply main may be of interest to those engaged in waterworks operation or installation.

The pipe line is 18-in., plain end, steel tubing, with Custer steel couplings, and furnishes the water supply for this city from a headworks reservoir at a distance of 18.3 miles. The line was constructed in 1912, and has since been in continuous operation, the repairs in the pipe line, with the exception of valves, having in the meantime been practically negligible.

DISCHARGE TEST ON 18-IN. STEEL MAIN FROM CARON HEADWORKS

Date of test	April 2nd, 1919.
Time of measurement	8 a.m. to 12 noon.
Depth of water taken into reservoir	8 ft. 1 in.
Capacity of reservoir per vert. ft.	49,100 Imp. gallons.
Discharge in 4 hours	410,147 Imp. gallons.
Capacity of pipe line per day	2,406,882 gals.=4.4572 sec. ft.
Length of pipe	18.3 miles=96.625 ft.
Diameter of pipe	18 ins.
Thickness of shell	¼ in.
Inside diameter	17.5 ins.=1.46 ft.
Net area of pipe section	1.67 sq. ft.
Velocity in pipe line	2.67 ft. per second.

Elevations

W. L. at headworks reservoir	1,889.00
W.L. at receiving reservoir at beginning of test	1,882.00
W. L. at receiving reservoir at end of test	1,830.17
Average W. L. at receiving reservoir during test	1,826.08
Average head	62.92 ft.

From which $f=0.0086$.

The coefficient of friction obtained is much lower than generally used or accepted for cast-iron or steel pipes when new, and is comparable with the coefficients claimed for wood pipe. The reduction in the size of a supply main for a stated discharge, using this coefficient, is very material.

J. CLARK KEITH.

Moose Jaw, Sask., April 9th, 1919.

PREVENTION OF WATER WASTE AND REASONS FOR METERING IN LARGE WESTERN CITY

NEW meter rates were put into effect last year by the Spring Valley Water Co. of San Francisco. The company has approximately 65,000 services, all of which are metered. In introducing the new system of charges the company supplied to each customer a pamphlet setting forth the reason for the changes and pointing out the advantages. Following are extracts from the pamphlet:—

Necessity for Waste Prevention

To meet the present urgent needs of the city and to prevent a possible future shortage, San Francisco's supply of water must be carefully guarded. The present sources of supply are now drawn to their full capacity, and, unless some of this supply can be saved, additional water must be secured. An additional supply can only be secured by building an additional pipe line to the city and after the pipe line is commenced, it will take three years to complete it. It is impossible to build this pipe line now, because, necessary labor cannot be secured, and steel plate and other materials absolutely essential in this construction are required by the United States Government. This means that for the next few years San Francisco must depend upon its present developed supply, and every effort must be made to make that supply sufficient to meet the city's needs. If this is not done, San Francisco will be short of water.

There is one way in which such a disaster can be prevented and there is only one way. It involves the elimination and prevention of waste. Waste of water can be dealt with effectively only by installing water meters. The California Railroad Commission has recognized these facts and has directed this company to install meters. The necessity for installing meters is recognized by every public authority conversant with the situation. This includes the city engineer, the engineers for the Railroad Commission, and the Railroad Commission itself.

Reasons for Meters

There are two reasons for installing water meters First: Their use directly reduces waste. When there is a meter on each service pipe, the party carelessly or wilfully wasting water is made to pay for it. Second: Meters prevent discrimination. When they are used the consumer pays only for what he gets and the company is paid duly for what it supplies.

The old rates, commonly called flat rates, were unfair. Under them you did not pay for water actually used, but bills were necessarily based on the water which you were supposed to use. This resulted in some consumers paying much more than they should have paid, and in others paying much less. There was no incentive to save and waste necessarily followed.

Most People are Careful

Most people are careful in the use of water. There are, however, a few whose carelessness or deliberate waste increases enormously the amount of water that must be provided. A leaking toilet may easily waste as much water as would serve 20 families. This water costs money to produce. If those who waste it do not pay for it the burden must be borne by all. This results in the public having a heavier burden to bear and each consumer paying a greater charge. This is particularly true in this city because every gallon of water in the street mains has been pumped from one to four times before it reaches its destination. Pumping requires the use of oil. The company used this year over 100,000 bbls. of oil, and the cost of oil has now increased more than 100 per cent.

What the Consumer Pays

In supplying water there are three operations:—

First: Developing and protecting the water at its source, collecting it in the large storage reservoirs, and pumping and conveying it to the city distributing reservoirs.

Second: Distributing water throughout the city through the main supply lines to the smaller regulating reservoirs, and finally through the distribution lines in each street.

Third: Maintenance and repairs to meters and services, inspection of plumbing and fixtures for the consumers, reading meters, bookkeeping, billing and collecting.

The charge to be made by this company on account of the first two items the Railroad Commission, by its ad interim order, established. It ranges from 24 cents for each 100 cu. ft. for domestic and small commercial consumers to 18 cents for each 100 cu. ft. for large industrial consumers. The reason for this distinction is that it costs relatively less to distribute water in large quantities than in small quantities. At the highest rate a barrel of water costs about one cent.

The third item forms the basis for what is known as the "service charge." This has been fixed by the Railroad Commission at 65 cents per month for ordinary household meters, and increases through intermediate charges to $40 per month for the large 8-inch connections.

Service Charge

Each individual consumer pays a specific amount for service rendered to him individually, and the amount which he pays is determined by the size of his service. Unless this is done all these expenses go into the general operating expense account and must be distributed among the consumers without regard to the service to the individual. The service charge is the most equitable arrangement. It is fairer than the "minimum bill" method.

The service charge is not an additional charge and does not mean higher rates. It is simply a different and more equitable way of distributing the cost of service among consumers.

Note that if there is a discontinuance of service, the service charge likewise stops.

The meter rates are ad interim rates. They were put in to prevent waste and to distribute fairly between the consumers the cost of supplying water. They were not put in to increase the company's revenue, and the order of the commission specifically provides that they shall not do so. The Commission's order says:—

"The proposal of the company is fair, to-wit: That the rates now established shall not result in any increased revenue or profit and in the event that through inadvertence or as a result of conditions impossible to estimate accurately, a greater revenue should be produced, all over-plus over present revenue shall be held at the disposition of the commission for the benefit of consumers."

Effect of Meter Rates

At least 50 per cent. of the company's consumers will pay less than they paid under flat rates. Many consumers will notice no appreciable change in the monthly charges. Others, particularly those whose water is wasted, will pay more than they have paid in the past.

Those who take large quantities of water and who get the wholesale rate will pay more. The old wholesale rate was too low and the Railroad Commission has decided that this class of consumers should bear a larger proportion of the whole cost.

Builders and contractors will pay materially less than under the old schedule. Bills for water service to vessels supplied at open docks will be much less. They were charged too much proportionately under the old rates. Several thousand small stores and shops previously paying the minimum of $1.80 per month will average a saving of between 25 and 50 per cent. By guarding against waste through faulty plumbing and exercising proper supervision of irrigation, at least one-half of the residential consumers should reduce their bills.

If your bill is higher than you think it should be, look first for waste. If you do not find it, see if you are not really using as much water as the bill calls for.

The company maintains a force of experienced plumbing inspectors. This force is at your service and will advise you upon request, free of charge. It is to our advantage, as well as yours, to eliminate waste, and to this end we seek your co-operation.

NEW SOFT WATER SUPPLY FOR GREATER WINNIPEG IS PUT INTO SERVICE

By W. G. Chace
Chief Engineer, Greater Winnipeg Water District

St. Boniface was the first of the municipalities associated in the Greater Winnipeg Water District to tap the new soft water supply,—on the afternoon of Friday, March 28th. The city of Winnipeg and those municipalities which receive their domestic supply from Winnipeg's mains were first supplied on Saturday, April 5th.

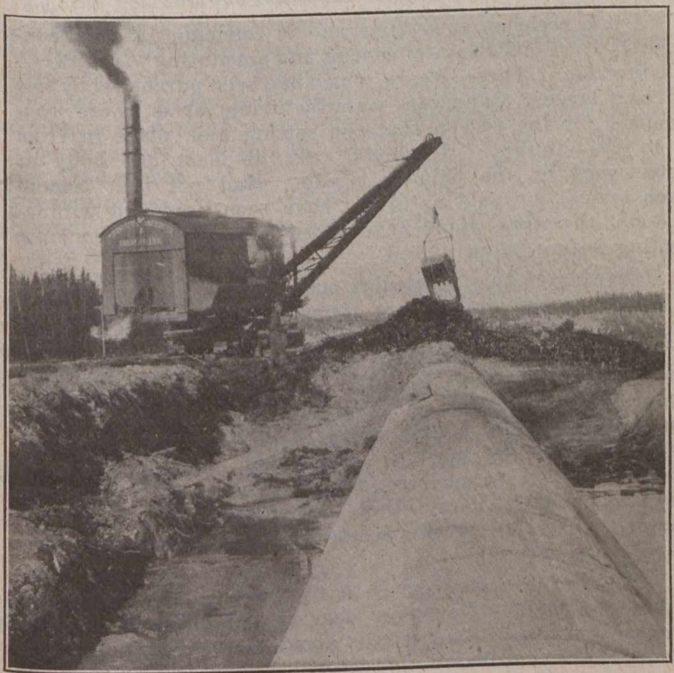
There is a general chorus of approval of the new supply, an appreciation of which may be understood when it is known that the previous artesian supply contained nearly 500 parts of hardness per million, whereas the new supply contains but about 40 parts.

The new supply, although coming from an open lake, is as colorless as was the sterile underground water previously used and contains but a minimum of living organisms, mostly invisible, since it is derived from a watershed wholly Laurentian and uninhabited except for a few Indians on their reserves.

These deliveries mark the successful completion of an ambitious project undertaken in 1913 and courageously carried through continuously in spite of the financial conditions which were caused by the great world upheaval.

Brings Water 95 Miles

The Greater Winnipeg Water District, comprising the cities of Winnipeg and St. Boniface, the town of Transcona and portions of municipalities adjoining Winnipeg and St. Boniface (namely: St. Vital, Fort Garry, Assiniboia, and East and West Kildonan) has an area of about 92 sq. miles. Pumping stations are maintained by the two cities and by Transcona, and the more thickly settled portions of the other municipalities receive water from extensions of the mains of the two cities.

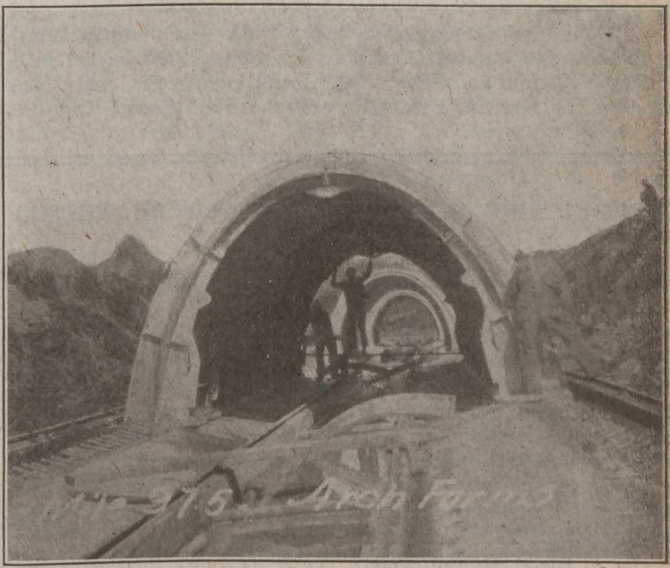


Backfilling 7 ft. 7½ in. by 6 ft. 5¼ in. Aqueduct in Wet Trench with Wet Material

The original report, upon the basis of which the citizens decided to develop the soft water scheme, was prepared by Rudolph Hering, Frederic P. Stearns and James H. Fuertes, whose estimate of the costs of the works necessary for the bringing of 85,000,000 Imperial gallons per day a distance of 96 miles, was $13,050,000. This estimate did not cover the cost of necessary lands, interest during construction, discount on bond issues, nor certain other recoverable but necessary, temporary, equipment items. Now it is proven that that amount of cash was sufficient, in spite of the extreme conditions of the labor and material market during the past four years, to build the works intended.

The three engineers suggested that five years would be the reasonable duration of period of construction, and except for one link the conduit was completed last autumn within the five year period. However, spring is the proper season in this climate for the substitution of soft water for the previous hard water supply, and it may be properly said that this, the largest municipal work hitherto attempted in Canada, has been completed on time and for the money estimated.

The debt created for the purpose becomes not only a lien upon the works constructed, but is also a first charge upon all the lands included in the district. The annual costs for interest and sinking fund are, by act of the Manitoba legislature, to be paid from taxes collected from assessment of the lands alone. The costs of operation and of maintenance of the works are to be collected by the district from the sale of water to the individual municipalities drawing same from the district's conduit. This year there were some protests made to the legislature, requesting certain modifications of these principles, but the questions were laid over for one year to permit thorough discussion by the interested parties.



Erecting Steel Arch Forms for 10 ft. 9 in. by 9 ft. Aqueduct

The new conduit delivers by gravity from Indian Bay, on Shoal Lake, Ontario, a branch of the Lake of the Woods, to reservoirs upon the surface of the ground at the western terminus, a total distance of 96.3 miles, with a total fall of 294 ft. The easterly 84.62 miles of this conduit, designed for capacity above mentioned, will deliver 100,000,000 Imperial gallons a day, and at the western end of this section there will be established in the future a 250,000,000-gallon reservoir; west of this point, 11.7 miles of pressure lines now built will have a capacity of 60,000,000 Imperial gallons a day and this portion in the future will be duplicated.

Nineteen Miles of Pressure Pipe

Of the entire length, 77.5 miles were built as a horseshoe-shaped, open-flow section, in sizes depending on the slope of the profile available, and 18.8 miles consists of reinforced concrete pressure pipe for heads varying up to 90 ft. Tests of individual sections of considerable length under full working pressures have shown that the losses of water will be negligible, totalling for the 96.3 miles less than two-tenths of one per cent. of the capacity of the structure. With the exception of about 1,200 ft. at the Red River crossing, the entire line is of plain or reinforced concrete.

The work was done almost wholly by local contractors. The Winnipeg Aqueduct Construction Co., an association of the Carter-Halls-Aldinger Co., and the Northern Construction Co., built the easterly 47.4 miles of the work, and in association with the Canada Lock Joint Pipe Co., this same firm built 9.3 miles of 66-in. by 8-in. reinforced concrete pressure pipe east of the Red River.

Wm. Smaill was superintendent for the company, and J. C. Mitchell was the indefatigable officer in charge for the Canada Lock Joint Pipe Co., which company also manufactured 2.3 miles of 48-in. by 6½-in. reinforced concrete pipe which was laid west of the Red River.

Thos. Kelly & Sons built 17.8 miles of the main aqueduct, constructed the Red River tunnel crossing with its appurtenant surge tank, and laid the pressure pipe west of the Red River.

J. H. Tremblay Co., in association with the J. McDiarmid Co., built 19.7 miles of the aqueduct just east of the future reservoir site.

All portland cement used in the work was manufactured by the Canada Cement Company at their 4,000 barrel mill in South Winnipeg. The reinforcing steel was manufactured by the Algoma Steel Co., and the Steel Co. of Canada. With the exception of cast-iron specials, which were manufactured locally, the special 60-in. cast-iron pipe for the lining of the Red River tunnel crossing was manufactured by the Warren Foundry and Machinery Co., of Phillipsburg, N.J. Valves were supplied by the Chapman Valve Mfg. Co., of Indian Orchard, Mass., and several other American manufacturers.

James H. Fuertes, of New York City, was consulting engineer for the district. M. V. Sauer was chief of design but resigned about eleven months ago to become designing engineer of the hydraulic department, Hydro-Electric Power Commission of Ontario, and was succeeded by James Hyslop. Division engineers, in sections of the aqueduct corresponding to contracts let, were A. C. D. Blanchard, D. K. McLean, Wm. R. Davis, G. F. Richan, John Armstrong, C. J. Bruce and W. D. Mackenzie. There was, throughout the work, the heartiest spirit of co-operation between the contractors, the engineers and the district forces which operated the necessary railway and gravel pits, with the aim of providing a stable, water-tight and efficient conduit, and of completing the work on scheduled time.

WHY BUILDING MATERIALS SHOULD BE TESTED

By Emmanuel Mavaut
Milton Hersey Co., Ltd., Montreal

ONE often wonders why it is that so many engineers and architects seem averse to having their building and structural materials inspected and tested before accepting them for use in their work. Too often this is omitted during the construction of high-priced dams, bridges, breakwaters, office buildings, theatres, etc., where the professional reputation of the engineer or architect, the capital of the investor, and quite frequently the lives of many people, are at stake.

Is it through ignorance? Is it through jealousy and selfishness, not wanting any other engineer or chemist to share the credit for the appearance or assured safety of the structure? Or is it through a mistakenly economical point of view?

To review these points one by one: Is it through ignorance? I may answer that in quite a few cases it is. Engineers of high standing have deliberately claimed to me that it was not necessary to test anything, using as an argument that cement is standard, that any experienced man can tell good sand at sight, and that so far as stone is concerned, limestone is limestone and that is all there is to it.

These men start work without knowing the quality of the materials they are using; and, too frequently, their structures fail. If it is concrete, the mass crumbles, disintegrates, cracks or otherwise goes to pieces, and the average person who sees it concludes that after all concrete is a poor investment.

Review of Opposing Arguments

Let us review the arguments of these engineers. They claim that cement is standard. I say it is not; though I know that the cement manufacturers, especially the larger ones, do all in their power to have the cement not only up to specifications but as near perfect as practically possible. But the chemist and superintendent can not be all over the works at once; and for that reason there is always a possibility, though it may be remote, of the cement coming out too fresh, too high in sulphuric anhydride or in magnesia, or too low in specific gravity.

These defects, which can not be found without having the cement tested, will cause many different troubles in concrete work. For instance, one defect will cause the cement to set too quickly; that is, it will take its initial and sometimes its full set before being placed on the job, or in other words, while the men are mixing it. In this case, there will be no cementitious qualities between the different lumps of concrete as it breaks up when being deposited, and so many stones covered with mud might just as well be thrown into the forms.

On the other hand, another defect might cause the concrete to set too slowly. This naturally retards the work, because the forms can not be taken off as quickly as planned. If the risk is taken and the forms removed, there is a great possibility of the structure failing. If slow setting cement is used in winter and freezes before it sets, the concrete will soon disintegrate. Even if it should not totally collapse, it will be a constant cause of expense for repairs and an ever-present eye-sore.

Not Always Manufacturer's Fault

I had occasion some time ago to condemn 18 cars, containing over 16,000 bags of cement and amounting to over $11,000 in value. These 18 cars, which had been purchased by two of our largest Canadian manufacturing firms, were condemned for the reason that the setting took place in from 8 to 20 minutes. It should take at least one hour as determined by the Gilmore needle. Had not that cement been tested, it would naturally have been used and without a doubt the work would have failed because of the concrete setting before being placed.

Outside of this particular case, I have had occasion to condemn cement quite a few times in different parts of the country. In the majority of cases, the cement manufacturer was not to blame for these failures in cement, but either the railway company or the contractor was responsible. Cement is often stored in unsuitable sheds, where dampness and rain injure it. How many of us have not seen bags that were set as hard as rock taken out of temporary storage sheds? In such an instance, while only certain bags may be unusable, many others, and frequently a very large quantity, have been affected to such an extent that they should not be used.

Another instance came to my personal attention last summer. An electric power development company situated in the province of Quebec was about to raise its dam. The cement was purchased and stored beside the falls in an enclosure with no front. After this was filled with cement, a few boards were put up to protect the cement from the spray of the falls; but cracks ranging from one to ten inches were in evidence. The result was that the spray reached many of these bags of cement, making some of them so hard they had to be broken up with shovels before being used. I drew the attention of the superintendent to this fact, but his answer was that the cement was first-class.

It stands to reason that had this cement been tested before being used, it would certainly have been condemned, as chemical action had already taken place, rendering it of little value. This is but one of the many cases where the cement company was not to blame, and similar instances occur almost daily; but, whether the manufacturer or the contractor is responsible, if the cement is not tested and the work supervised by an experienced concrete inspector, the investor is likely to suffer.

Now let us go into the sand question. It is claimed that any engineer or experienced man can tell good sand at a glance. That is impossible. He may be able to tell that it is too fine if it is very much too fine, or too dirty if it is very much too dirty; but beyond that there are no engineers or experienced men who can tell at sight whether this or that sand is good and reliable for strong and dense concrete work.

All sand contains more or less silt or dirt. The reason for this is that it is composed of small particles of broken rock of different sizes and compositions, coming from different parts. These particles have been washed away or transported from their different sites at different times and settled in layers of different thicknesses in what is now a workable sand bank or deposit. Therefore there is no guarantee or even likelihood of uniformity, and one car load of sand may be first-class and the next of very poor grade for concrete work.

Also the dirt and silt, which are very often injurious to sand for concrete purposes, are bound to be present in some parts of the sand bank; because the small particles of rock that are washed towards the bank will naturally carry with them more or less of this fine material.

The above shows conclusively that in order to be sure of good results, the sand should be tested not only once but continually while the work is in progress.

Besides the avoidance of injurious silt, there is to be considered the size or grading of the sand. It should be well graded, having a certain proportion retained on each sieve from, say, the eighty-mesh to the one-quarter-inch sieve. If all of the sand grains are of nearly the same size, the voids will be too great and unless an additional amount of cement is used, the voids will not be filled. If too fine, the concrete will not be of the required strength. The reason for having sand well graded is so that the fine particles will fill the voids left by the coarser particles, thus reducing them to a minimum.

In order to properly proportion a concrete mixture, it is necessary to determine the voids; without this information, the engineers are working blindly and probably wastefully. Where they are figuring on having a dense concrete for a reservoir, oil tank or foundation, the result is apt to be different; and if the water goes through the wall, concrete once more gets a black eye.

Another very bad fault in some sands, which can not be determined without testing, is that they contain injurious chemicals. Sometimes the drainage from some industrial plant such as a chemical works, soap factory or tannery, though located several miles away, will contaminate a sand supply, rendering it unfit for use in making concrete. As a rule, such contamination is discovered by making three-to-one briquettes with the sand under consideration and also with standard sand. A comparison of the results will soon tell whether or not injurious chemicals are present.

Sand Saturated With Ammonia

Some years ago I had occasion to deal with a very interesting case of the above type. A company decided to build a concrete laundry building in eastern Ontario on the site where an old stable had been standing for years. They tore down the old building and in excavating for the cellar of the new, ran across such nice-looking sand that they decided to use it in the concrete mixture for the new structure. They had no end of trouble. The concrete would not set and the walls fell in. In carrying out an investigation, it was found that briquettes made of this sand would crumble in the hand after seven days' setting. These briquettes were so disintegrated that they could not even be put in the machine to be tested. An analysis was made, and we found that the sand was saturated with ammonia which had percolated through from the horse manure.

As a result of this investigation, the sand had to be taken away from the site of the work, the old concrete thrown out, forms rebuilt, new sand purchased and the work reconstructed. All this delayed the work, cost money for material and labor to replace that wasted, and inconvenienced the owners. A sensible program of testing would have prevented any of this trouble.

I would venture to say that three-quarters of the failures in concrete are due to poor sand; and yet some engineers will not hesitate to state that it is unnecessary to test sand.

So far as stone is concerned, the same argument holds as in the case of sand. In order to regulate the mixing of concrete, the voids must be determined; and in order to get good results, the stone must be clean, strong, well shaped and well graded.

It might well be stated that the best argument for the general inspection and testing of all building and structural materials is that every large corporation such as the Canadian Pacific; the Grand Trunk; the Canadian National Railways; the Montreal Tramways; the Montreal Light, Heat and Power Co.; the Harbor Commissioners of Montreal; the cities of Toronto, Hamilton, London and Peterborough; the departments of the government, provinces, states; the counties and municipalities that are at all progressive; and large private concerns too numerous to mention, all have their materials thoroughly tested before using them. The sooner other engineers and architects make up their minds to have testing and construction supervised by experienced men, the sooner eye-sores, failures and constant repairs to concrete work will stop.

One City's Hard Luck

Is it through selfishness? I happened to interview the city engineer of one of the larger cities of Canada on the subject of supervising concrete construction and the testing of materials for same. After a long conversation, he agreed that the construction materials should be tested, but turned around and said, "Where do we come in? You will be the party doing the work, and getting the credit. The municipal council will say, 'These engineers of ours are no use if they must get their materials tested and work supervised.' If we were to do that, we might find ourselves out of a job."

Whether it is the effect of the above policy or not, it is hard to say, but this particular city has had constant trouble and very heavy expenditures for replacing defective work; which expenditure has, of course, fallen upon the taxpayer. They erected a fat-stock show building and the whole thing collapsed. Their water-main cracked, and as it was a suction system, sewage, and polluted water were drawn into the mains and contaminated the drinking water. This caused a typhoid fever epidemic that carried off in the neighborhood of a thousand people and forced the city to open emergency hospitals that they had to furnish and provide with doctors, nurses and orderlies. The boiler in one of their municipal buildings exploded, killing one man, injuring others and wrecking the building. A pavement about twenty-five city blocks in length took on the form of a corrugated road and had to be relaid a few years after it was first put down.

It goes without saying that all this trouble cost the city many thousands of dollars, which expense might and very likely would have been avoided had all the materials used in these constructions been tested and the work supervised by someone particularly familiar with each type of construction. Any possible loss of prestige to an engineer or architect through the employment of outside, specialized inspection and testing, could not conceivably injure him as much as one such failure as I have mentioned. In fact, after the failure, some one will ask why he did not have knowledge enough to understand that he needed such specialized service. The family physician does not try to operate on his patient's heart; the city engineer should not think it necessary to pretend that he knows it all either, and the same applies to the outside engineer or architect. Specialists usually pretend to know but one thing, but to know that one thing uncommonly well.

Is it through an economical point of view? With some engineers and architects it is. A good many of them will say that this or that work is not of sufficient importance,

(Concluded on page 413)

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PRINCIPAL CONTENTS

THE K-TRUSS DESIGN

AT the last meeting of the Montreal branch of the Engineering Institute of Canada, G. H. Duggan, in a paper on the Quebec bridge, remarked that efforts had been made to take from Phelps Johnson the credit for the "K" design of bracing which Mr. Johnson had practically introduced to the engineering profession. Russian engineers had used a sort of "K" bracing, but Mr. Johnson had known nothing of it, and moreover it was not in the form that was designed by Mr. Johnson and used for the Quebec bridge.

FIRST CANADIAN RAILWAY TROOPS

AN enviable record in military railway construction was made by the 1st Canadian Railway Troops in France when this unit built a railway 173 miles long, standard gauge, under front line conditions, in 90 days. Nor was this record an isolated achievement of this force, whose exploits at Cambrai and later in other sectors resulted in their being showered with the congratulations of the British Commander-in-Chief, Sir Douglas Haig, General H. Rawlinson, commander of the fourth army, and Major-General S. D. Cruickshank, director-general of transportation. Lieut.-Colonel Blair Ripley, who commanded the 1st C.R.T. overseas, arrived in Toronto last week, after having crossed on the Scotian, and was persuaded by the daily newspaper reporters to give a brief account of the feats of his unit. Col. Ripley is well known in engineering circles as the engineer in charge of grade separation for the C.P.R. For his service in Flanders he has been twice mentioned in despatches and awarded the D.S.O. After a brief vacation, Col. Ripley will resume his former position with the C.P.R.

THE WAGE EARNER'S VIEWPOINT

SENATOR Gideon Robertson, the new Minister of Labor, has earned a good reputation in the handling of industrial difficulties; he has the labor situation well in hand. Some of his opinions expressed before the Association of Montreal Building and Construction Industries on April 11th, deserve the serious consideration of employers.

The minister showed how relations between employers and employed have changed during the past twenty-five years. The growth of industrial plants has led to the number of workmen becoming so great that the employer has no individual contact with them, since he does not even know them, and on the other hand very often the employes do not know who the proprietors or employers are. To-day the workingman feels that he ought to receive more recognition and that he ought to be reasonably and adequately paid so that he may live with at least the same degree of comfort as he enjoyed in pre-war days. Not only that; he has conceived the idea that he is worth more than he thought himself worth in the pre-war days. There has come to the workingman a self-confidence that he did not possess five years ago, which is due to the great things accomplished during the stress of war, both in the provision of war munitions and in the loyalty and the sacrifice that the workingmen of North America and of Europe had shown. Although the armies of the world were composed mostly of workingmen, yet they represented but a small part of the property and wealth which they fought to save. As a result many of them are taking the view to-day that the process followed in the past has been too gradual and too slow, and that it is now incumbent upon them to be more militant than formerly, and in some countries that feeling has so grown that it has become a menace to society. Happily this is not the case in Canada and the senator thinks it never can be so, for Canada is a democratic country and the great majority of the people are financially interested in the nation. "But I think it behoves all business men and employers of labor to give heed to the changing times and to realize that this spirit is growing and will continue to grow among workingmen unless they are convinced that they will be fairly treated," said Senator Robertson.

The minister of labor referred to recent labor events in England, where he said it was only by the adoption of very unusual methods that serious disaster had been averted. Canadian employers and employees both stand to benefit by these changes, as under the new conditions Canada can better compete with England. But if Canada is to prosper and develop industrially, there must be a maximum of efficiency displayed not only by employers in management, but by workmen in their work. It is unfortunately true that too many men have sought rather to see how little they could do for their day's pay than endeavor to give honest service for reasonable compensation. Senator Robertson urged that a spirit of co-operation in all industries should be fostered, and he argued that if Canada prides itself on being a democratic country, it is also desirable that where a large capital was invested in a particular industry which is helpless to produce profit without the assistance and co-operation of the necessary labor, the advisability of that labor being consulted in the operation and management of the industry so far as the interests of employer and employee were mutually concerned, should also be considered. He did not mean to suggest that the workmen ought to have any control or voice in the capital expenditure or the use of money invested, but so far as their own services were concerned they had some claim to be heard.

"The thought that is prevalent in the minds of hundreds of large employers to-day," continued the minister of labor, "and also in the minds of many workmen, is why should this situation grow any more acute? Why should we not emulate the example of the great nations of the world and now try to adopt a spirit of co-operation and arbitration to settle our differences rather than dispute the claims of the other fellow?" However, the workingman must recognize, concluded the minister, that there is a limit to the employer's ability to meet ever-increasing demands.

LIEUT. JOHN W. DORSEY ALIVE

An error was evidently made by the Statistical Division of the United States army in reporting that Lt. John W. Dorsey, of Winnipeg, was deceased. A letter addressed to Lt. Dorsey had been returned stamped, "Deceased, verified Statistical Division A.E.F.," As a result an obituary notice was published in last week's issue of *The Canadian Engineer.* Just a few days ago a letter was received from Lt. Dorsey by the authorities of the University of Manitoba, where Lt. Dorsey was assistant professor in mechanical and electrical engineering before his enlistment, stating that he was well and expecting to return home soon. This was the first letter that had been received from Lt. Dorsey in some time and until its receipt it was not known whether the report received from the Statistical Division of the American army was correct or not. A request has been made to the War Department at Washington, D.C., for information, but no reply has yet been received. It is thought, however, that the return of the letter stamped as it was, must have been an error, as Lt. Dorsey's letter was received subsequently and had been written recently. There is an old saying that he who is falsely reported dead will live to a very old age, and in this well-known proverb Lt. Dorsey's many friends in Winnipeg and elsewhere will find much comfort.

WHY BUILDING MATERIALS SHOULD BE TESTED

(Continued from page 411)

or will not be seen, so spending money on tests for it is wasting. This is very unwise economy; in fact, not economy at all. It is a case of saving the pennies to throw away the dollars, for when the construction materials are tested and accepted by specialists, and the work supervised by them, the engineer or architect is practically relieved of all responsibility except that of having selected competent specialists to do the work. He can not do all this himself. He must hire some one, so why not those particularly competent to take care of the particular matter for him?

Besides, if his plans and specifications are correct, he is sure that there will be no unwarranted expense for repairs and the structure will be there to stay as a monument to his name and a foundation for his future reputation in the engineering profession.

The engineers and architects who are foremost in their professions would not consider for a moment the proposition to have their plans and specifications executed without full inspection and testing as the work progresses; therefore, why should men who have not yet reached the pinnacle of professional success, risk failures that might forever preclude their arrival?

PERSONALS

Capt. F. A. Dallyn, sanitary engineer of the Ontario Board of Health, who is in Siberia with the Canadian expeditionary force, is ill with typhus fever, says a message received by Dr. J. W. S. McCullough, the chief officer of health of Ontario.

A. H. Dixon has been appointed chief engineer of Western lines, Canadian National Railways, succeeding the late A. T. Fraser, who was recently killed in a snow-slide at Nelson, B.C. Mr. Dixon was formerly G.T.P. district engineer at Vancouver.

Capt. A. M. West, of Vancouver, recently returned from France, where he served with the 9th Field Company, Canadian Engineers. He was wounded twice, and in January, 1918, was mentioned in despatches and awarded the military cross. Capt. West graduated in Applied Science at the University of Toronto in 1910.

Lieut. W. D. Proctor, of Sarnia, Ont., has returned from France, where he has been on active service for two years. He enlisted in the 3rd Battery, and while in France was transferred to No. 2 Tunnelling Company, Canadian Engineers. He received his commission shortly before the signing of the armistice. Lieut. Proctor is a science graduate, class '17, University of Toronto.

Roger DeLand French, engineer of the Lignite Utilization Board of Canada, has presented to the Board an exhaustive report on methods of briquetting now used throughout the United States, and suggested improvements in these methods which, it is said, will result in the Board's $400,000 plant near Estevan, Sask., being the most advanced plant of its kind in the world, so far as design and methods are concerned. In this report and the work of investigation, Mr. French had the co-operation and assistance of Edgar Stansfield, chemical engineer of the Board. Mr. French was born and educated in Massachusetts. He graduated in 1905 from the Worcester Polytechnic Institute, and joined the staff of Prof. Malverd A. Howe at Terre Haute, Ind., assisting in the revision of Prof. Howe's "Treatise of Arches" and in the design and construction of a number of concrete arch bridges. In 1906 he returned to Worcester as a student-instructor, and spent two years in a post-graduate course. During this time the institute carried out a programme of extensions and improvements for which Mr. French acted as resident engineer, the expenditure totalling approximately $300,000, including reconstruction of laboratories, construction of roads and walks, conduit work, forestry, etc.

Having obtained his C.E. degree, Mr. French left the institute in 1908 and was engaged as engineer by the Sewerage Commission of Louisville, Ky., who were then engaged in spending about $4,500,000 in the construction of 180 miles of sewers. Two years later he became engineer for the National Concrete Construction Co., Louisville, and during his connection with this firm it erected bridges, buildings, etc., throughout the Southern states that had an aggregate value of about $1,000,000. In 1911, Mr. French went to Montreal and was engaged as principal assistant engineer by the firm of R. S. & W. S. Lea, consulting engineers. During his seven years' connection with this firm, he was engaged in design and supervision for a great many Canadian municipalities in connection with waterworks plants, sewerage systems, etc. In 1918, Mr. French resigned this connection to enter the office of Arthur Surveyer, consulting engineer, Montreal, but upon the formation of the Lignite Utilization Board a few months later, Mr. French was asked to undertake the engineering work of that Board. In addition to his professional work, he has served since 1911 as a lecturer in the municipal engineering course, Faculty of Applied Science, McGill University. He has taken an active interest in the civic affairs of the Montreal suburb in which he lives, and is secretary of a joint town-planning board that was created by five municipalities adjoining Montreal.

R. J. Lecky, general contractor, Regina, has received his discharge from the army and has re-opened offices as an engineering-contractor.

Joseph N. de Stein, formerly resident engineer of the G.T.P. R'y. at Regina, has joined the Parsons Engineering Co., with offices at Regina.

J. B. Tyrrell, mining engineer, Toronto, has been elected a member of the council of the Institution of Mining and Metallurgy of Great Britain, to fill the vacancy caused by the election of Sir Robert Hadfield to the vice-presidency.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer* to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Beebe Plain, Que., highway	May 1.	Mar. 20.	43
Campbellton, N.B., school	May 1.	Apr. 3.	44
Central Butte, Sask., school	Apr. 30.	Apr. 17.	46
Charlottetown, P.E.I., wharf	Apr. 28.	Apr. 17.	50
Guelph, Ont., paving	May 1.	Apr. 17.	44
London, Ont., school	May 1.	Feb. 27.	44
Ottawa, Ont., bridge	Apr. 26.	Apr. 10.	41
Ottawa, Ont., Parliament Buildings	Apr. 30.	Apr. 10.	52
Regina, Sask., bridges	Apr. 26.	Apr. 10.	41
Sherbrooke, Que., highway	May 1.	Jan. 23.	44
St. Severe, Que., roads	June 2.	Apr. 10.	42
Swan River, Man., roads	May 5.	Apr. 17.	43
Vancouver, B.C., hospital	Apr. 30.	Apr. 17.	50

BRIDGES, ROADS AND STREETS

Beauceville, Que.—Armand Dupries, Quebec, has the contract for construction of roads costing about $60,000.

Botsford, N.B.—The contract for the construction of the Chapman Pond bridge has been awarded to Alexander and Roy Forbes, South Devon, N.B. Cost about $12,000.

Bowmanville, Ont.—A representative of the Ottawa Paving Co. has estimated the cost of paving King St. at about $50,000. Mr. Quinn, councillor.

Chatham, Ont.—Improvements are being made to the River Rd., near the House of Refuge. County engineer, Mr. McGeorge; road superintendent, L. A. Pardo.

Ford City, Ont.—Merlo, Merlo and Ray, contractors, have been awarded the contract for the paving of Cadillac St. and Rossini Boulevard, by the City Council.

Frampton, Dorchester, Que.—Tenders will be received by the undersigned up until noon, April 29th, for building a portion of road between Frampton and St. Malachie, through the municipality of Frampton from St. Malachie line up for a distance of about seven miles. Plans and specifications, also forms for tenders, may be seen at the office of the undersigned. Lowest or any tender not necessarily accepted. F. E. Boutin, M.D., secretary-treasurer, Frampton, Dorchester, Que.

Halifax, N.S.—Tenders are invited for the grubbing of approximately 2¼ acres of land, the diverting of a brook and the building of approximately 750 feet of roadway, 15 feet wide, for the Mount Olivet Cemetery Co., Ltd., at Mount Olivet cemetery. Plans and specifications of the proposed work may be seen at the office of the engineers, Pickings and Roland, Silver Building, Halifax, N.S.

Hamilton, Ont.—The government will spend $200,000 on improving the harbor this year. Also the first section of the bascule bridge, at the Burlington Canal, will be constructed. C. W. Kirkpatrick, industrial commissioner.

Hamilton, Ont.—West End residents have decided to petition the Town Planning Commissioners to open a number of streets westward over the T., H and B. Ry. tracks, between Main St. and Aberdeen Ave. Mayor, Chas. G. Booker.

Harding, Man.—Tenders will be received by the undersigned up to May 1st next for the grading and pipe-laying on the following roads: Breadalbane Rd., 4½ miles; Lenore Rd., 10 miles; Virden Rd., 5 miles; Crandell Rd., 2 miles; Kenton Rd., 1 mile; Pope Rd., 5 miles. Plans and specifications may be seen at the office of the undersigned, or in Winnipeg. W. Stevenson, secretary-treasurer, Municipality, Woodworth, Harding, Man.

Islington, Ont.—Construction of tar macadam pavements for several miles on Queen St., is planned by the Township Council. Estimated cost, $30,000. Frank Barber, 40 Jarvis St., Toronto, township engineer.

Kentville, Ont.—The Town Council will enter upon a program of paving streets, and expect to call for tenders shortly. Cost of proposed construction, $50,000. Clerk, J. Carroll.

Kingston, Ont.—The Board of Works intends to construct about one and a half miles of pavements this year. City engineer, R. J. McLelland.

Lotbiniere, Que.—Tenders will be received until May 12th for construction of bridge. Plans and specifications may be obtained at the office of J. Bedard, Ste. Croix, secretary-treasurer. Estimated cost, $38,000.

North Temiskaming, Que.—Tenders addressed to the undersigned will be received until noon, May 13th, for the construction of the superstructure of a bridge, consisting of four spans, over the Quinze River at North Temiskaming, Pontiac County, province of Quebec. Plans and forms of contract can be seen and specifications and forms of tender obtained at the offices of the District Engineers, Shaughnessy Building, Montreal, Que.; Equity Building, Toronto, Ont., and at the Post-Office of Hamilton, Ont. R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Sawyer and Smith, Galetta, are the contractors for constructing bridge and piers in the County of Carleton.

Ottawa, Ont.—Tenders addressed to the undersigned will be received until noon, May 1st, for the painting of the bridges at Portage du Fort and at Bryson in the County of Pontiac, Que. Forms of contract can be seen and specification and forms of tender obtained at this department and at the post offices at Portage du Fort and Bryson, Que. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Owen Sound, Ont.—Tenders will be received by the undersigned until 6 p.m., April 28th, for construction of steel bridge. Plans and specifications may be obtained from the county engineer, R. McDowell. Superintendent, J. Johnson.

Paris, Ont.—The estimate of expenditure to be made on the system of country roads totals $121,604.40. The following statement shows how it is divided: Road construction—County, $39,072.64; province, $44,581.75. Bridge construction—County, $3,000; province, $2,000. Machinery—County, $6,000; province, $4,000. Maintenance and repairs—County, $7,720; province, $2,830; city, $9,500. A road surface is to be laid on the Waterford Rd. at an estimated cost of $20,000. On the Harley and the St. George Rds. $8,000 is to be spent for each. West of Burford village on Road 15 a new bridge will be built costing $5,000. The sum of $20,000 for road construction will be used for long-needed construction on either the Paris or Burford Rd.

Pembroke, Ont.—E. A. Dunlop, M.P.P., has forwarded the following list of grants for colonization roads, township roads and bridges in North Renfrew for 1919: Alice and Fraser Tp., roads, $1,000; Alice and Fraser Tp., bridges, $500; Bromley Tp., roads, $725; North Algona Tp., roads,