PAGES

MISSING

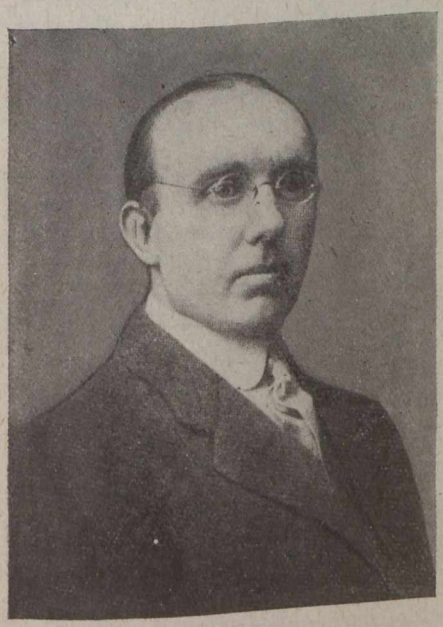
The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

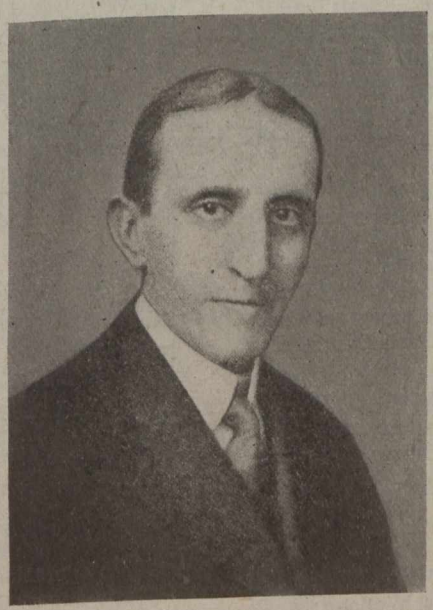
Canadian Section for Water Works Association

Canadian Members Form Seventh Section—Officers of Section Elected—Official Welcome of Association by Mayor of Montreal and President of Engineering Institute of Canada—Association Officers Elected—Canadians Registered

CANADIAN water works engineers and officials are hence-forth to form a special section of the American Water Works Association. On Tuesday, June 22nd, concurrent with the convention of the association held in Montreal from June 21st to 25th, the Canadians gathered together to the number of forty-four resolved to form a section of their own. Officers for the new section were elected for the ensuing year as follows: Chairman, Alex. Milne, of St. Catharines, Ont.; vice-chairman, F. H. Pitcher, of Montreal; secretary-treasurer, H. G. Hunter, of Montreal; trustees, R. L. Dobbin, of Peterborough; R. C. Harris, of Toronto, and Arthur Surveyer, of Montreal. W. H. Hammond, of Lindsay; MacHarvey McCrady, of Montreal; J. J. Salmond, of Toronto, and C. W. Scheidel, of Waterloo, were appointed a committee to draft a constitution for the section.



JAMES M. CAIRD
Treasurer, American Water Works Association



BEEKMAN C. LITTLE
President, American Water Works Association

EDWARD BARTOW
Vice-President, American Water Works Association

There are now seven sections in the association, namely, Central States, Four-State, Illinois, Iowa, Minnesota, New York and Canada. The Central States section comprises Ohio, Indiana, Michigan and Western Pennsylvania. The Four-State section is made up of Southern New Jersey, Eastern Pennsylvania, Maryland, Delaware and District of Columbia.

The convention of the association opened on Monday evening in the Exhibition Hall, Windsor Hotel, with official greetings from the city of Montreal, and from the Engineering Institute of Canada.

Mayor Mederic Martin welcomed the association with an expression of appreciation of the aims and objects which the association had in view, and of the significance of the subject of water supply in municipal administration. He found that the importance of city water supply had been fohcibly impressed upon him by the conditions brought about by the strike of last winter which occurred in Montreal, and he commented upon the meaning expressed in efficient water supply in the prevention of disaster and the preservation of health. That Montreal was entirely surrounded by water did not mean that the problem was already solved. Successive administrations during the past seventy-five years had given the subject their earnest attention, and large sums of money had been appropriated for improving the water works system. He was, therefore, brought officially and otherwise into recognition of the significance of their work, and he voiced his personal and official feelings in bidding them hearty welcome, and in hoping that Montreal would leave in their minds a pleasant impression of its hospitality.

R. A. Ross, president of the Engineering Institute of Canada, said that it gave him pleasure to be privileged to welcome the association. on behalf of the Engineering Insti-

tute, more especially because of the friendly relationship between the two organizations and the similarity of the ideal to which they were aspiring. He assured them that all the appurtenances of the Institute were at their disposal, and that its library and apartments were open to their accommodation. He recalled what the Institute members had done in the crisis of the strike extremity, referred to by the mayor, in donning their overalls to help the city through. No more vital blow could be made at the life of a city than to cripple its water supply. It constituted the solar plexus of the municipal system.

Mr. Carleton E. Davis, president of the association, voiced the pleasure that they felt in coming to Montreal and the consciousness that came to them when crossing the border that they were coming to an hospitable land. The delegates and ladies were then entertained by an orchestral concert, which with dancing and refreshments served to provide an enjoyable evening.

While the election of officers was not completed until later in the week, a certain number of them were chosen early in the week by postal ballot. Announcement of the election of the following gentlemen for the ensuing year was made on Tuesday: President, Beekman C. Little, Rochester, N.Y.; vice-president, Edward Bartow, Urbana, Illinois; treasurer, James M. Caird, Troy, N.Y.; trustee (second district), Harry F. Huy, Buffalo; (fifth district), Robert J. Harding, San Antonio, Texas.

Canadians Registered First Day

The Canadians registered up to Monday evening comprised those whose names appear below. Very many more registered later.

Charles P. Casgrain, manager, Waterworks, Quebec; Aime Cousineau, Health Department, Montreal; W. K. Dalglish, General Supply Co. of Canada, Ottawa; R. L. Dobbin, Waterworks Department, Peterborough; Ernest Drinkwater, town engineer, St. Lambert, Que.; J. A. Duchastel, city engineer and manager, Outremont, Que.

Frederick E. Field, Montreal West.

Geo. B. Greene, General Supply Co. of Canada, Ottawa; A. K. Grimmer, Temiskaming, Que.

Charles Hale, superintendent waterworks, Montreal; Francis Harkin, Francis Hankin & Co., Montreal; S. T. Hard, Neptune Meter Co., Ltd., Toronto; E. M. Hulbert, Jenkins Bros., Ltd., Montreal; H. G. Hunter, New York Continental Jewell Filtration Co., Montreal.

Ray Knight, Francis Hankin & Co., Montreal.

F. C. Laberge, Montreal; Albert A. Laflin, superintendent waterworks, St. Stephen, N.B.; Theo. J. Lafreniere, Montreal; Edward Laurie, Montreal; Pierre Leclerc, division superintendent waterworks, Montreal; Thos. Wm. Lesage, superintendent waterworks, Montreal; James Leslie, Canada Fire Underwriters' Association, Montreal.

W. E. Macdonald, city water works engineer, Ottawa; J. R. McCallum, Board of Water Commissioners, Welland; F. R. McKechnie, McKechnie & McLaren, Montreal; Alex. Milne, St. Catharines.

Horace Chas. Nixon, Sanitary Engineer, Saskatoon.

Joseph O'Neill, superintendent meter and inspection, Department of Water, Montreal; S. A. Ord, Preston Light and Water Co., Preston; Henry Ortiz, Grand Mere Water Board, Grand Mere, Que.

William Perry, hydraulic engineer, Montreal; F. H. Pitcher, Montreal Water & Power Co., Montreal; Adrien Plamondon, engineer and contractor, Montreal.

W. H. Randall, Neptune Meter Co., Ltd., Toronto.

Jas. J. Salmond, president and general manager, *Canadian Engineer*, Toronto; A. U. Sanderson, superintendent filtration plant, Toronto; C. W. Schiedel, water works, Waterloo; W. R. Stavert, Jenkins Bros., Ltd., Montreal; Lieut.-Comm. Chas. Stephen, Montreal.

Joseph Tremblay, manager water works, Montreal.

Charles Warder, superintendent water works, Niagara Falls; N. McL. Ramsay Wilson, Water Commissioners, Brantford; David L. Webster, Water Commissioners, Brantford.

THE MUNICIPAL WATER SUPPLY OF MONTREAL*

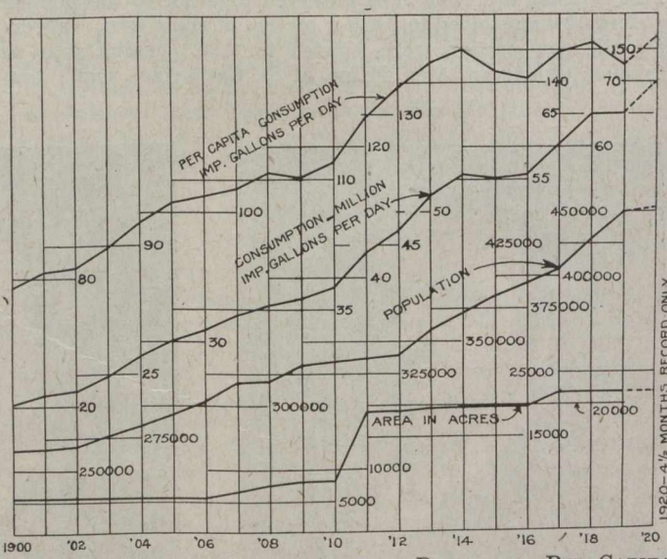
By T. W. Lesage
Engineer, Water Works Department, Montreal

MONTREAL, the commercial metropolis of Canada, has a population of close to 700,000 inhabitants, making it the sixth largest centre of population on the North American continent. Within its administrative limits proper, the city comprises an area of about 28,400 acres, and contains a population of 694,000.

There are in Montreal two water supply systems, the city municipal system supplying the main portion of the city, to the extent of about two-thirds of the above population, and a private water company, the Montreal Water & Power Company, supplying about one-third of the population, besides two towns outside the limits of the city.

Early Supply Systems

In 1852, after a serious fire had destroyed part of the city showing the inadequacy of the existing water supply, a report was prepared and submitted by T. C. Keefer to provide a supply from the head of the Lachine rapids, with an open canal 4½ mi. in length, with sufficient fall to supply the water and hydraulic power to pump 5 million Imperial gallons



Montreal Water Works—Average Daily and Per Capita Consumption and Population and Area Served

per day to the proposed McTavish reservoir at an elevation of 204 ft. above the river. These works were carried out and put into operation in 1856.

The supply had to be supplemented by steam pumps in 1868, as the city's water consumption had outgrown the 5-million-gal. capacity of the hydraulic pumping supply.

Enlargement of the Aqueduct

Meantime, the project of enlarging the old aqueduct to utilize the power for pumping sufficient water in keeping with the city's wants, came up at various times. Finally, in 1905, estimates were prepared for widening the aqueduct to develop water power sufficient to pump 50 million gallons and to build an intake out from shore and a concrete supply conduit to bring water to the steam pumps, whilst the aqueduct was being widened. The works began and the concrete conduit put in operation in the fall of 1909, when the aqueduct was emptied and contracts let for its widening.

In 1910, and before the contractors had completed the first widening, a further change of plans was decided on. This contemplated a still greater increase in the dimensions of the aqueduct, to afford sufficient water power to supply

*From a paper presented at the Convention of the American Water Works Association, Montreal, June 21-25, 1920.

and pump 100 million gallons per day. This project was put under contract in 1913, but was discontinued in 1916 as unprofitable, owing to various circumstances and changes of conditions, such as the breaking out of the war, and the reduced cost at which purchased power for pumping could be obtained, by reason of the great increase in water power development around Montreal, since the aqueduct widening was first mooted. These delays and interruptions in carrying to completion the aqueduct widening will serve to explain the heterogeneous character of the main steam pumping plant at the present day.

In 1909 it was surely thought that the city within three years would have its pumping done by water power to the extent of 50 million gallons per day. Again in 1911, after the changes in plans to enlarge the projected capacity from 50 to 100 million gallons per day, it was again considered certain that within five years time, or by 1916, the city's pumping would be all done by water power, and the old steam plant would be left to be remodeled at leisure, to serve as a reserve.

Meantime, the water consumption was increasing by leaps and bounds. In the four years, 1910-1914, the daily average consumption increased from 38⅔ to 55¾ million gallons per day, or over 44 per cent., a greater rate of increase than it had shown in the preceding nine years. During this time steam pumps and boilers were added from year to year, as the wants required and as expediency suggested, within the restricted limits of the pumping station area.

Description of Existing Supply

The city's water supply is drawn from the St. Lawrence river about a mile above the Lachine rapids, and at a distance of about five miles from the city. The supply intake is 1,200 ft. from shore, the river at this point being about three-fourths of a mile wide. The water is brought down by gravity a distance of 5¼ mi. to the main pumping station, through a covered concrete conduit, circular in shape with flattened invert, practically of 8½ ft. in diameter, having a capacity at the lowest stages of the river, of 80 million Imperial gallons per day.

At the lower end, and to the south of this supply conduit, is the filtration plant, to which the water is led by gravity. Raised by low-lift pumps to the prefilters, the water flows thence to the final filter beds and the filtered water reservoir, being repumped from there to the level of the suction well feeding the main supply pumps. The filtration plant of 50 million Imperial gallons' capacity at present, filters only about three-fourths of the water supplied the pumps. Plans for its enlargement are under way. The whole supply is, however, sterilized by hypochlorite.

The main or low-level pumping station situated at the end of the supply conduit, near the south-western limits of the city has a pumping capacity of 108 million Imperial gallons per day, furnished by means of eight steam pumping engines as follows:—

Pumping Engines Nos. 1, 2 and 4, of the horizontal reciprocating type, Worthington Duplex high-duty steam pumping engines with combined daily capacity in Imperial gal.	30 Millions.
Pumping Engines Nos. 3, 5, 6 and 7, of the centrifugal type, high lift pumps, direct connected to high-speed vertical triple expansion engines working at 350 r.p.m., with combined daily capacity in Imperial gal...	48 Millions.
Pumping Engine No. 8, De Laval centrifugal high-lift pump geared to steam turbine, with daily capacity in Imperial gal.	30 Millions.
Total of 8 pumps with daily capacity in Imperial gal.	108 Millions.

The oldest of these pumps, Nos. 1 and 2, were installed in 1886 and 1893 respectively. They are the least efficient machines of the pumping plant, and are to be replaced within a year by two 30-million-gal. electrically-driven high-lift centrifugal pumps for which contracts have been let. No. 4 pump. installed in 1905, is of more modern type with a trial duty test of about 160 million foot-pounds. The four high-lift centrifugal pumps driven by direct-connection to triple expansion vertical engines of enclosed type at 350 r.p.m., installed from 1909 to 1913, are representative of the change from the reciprocating to the high-lift centrifugal type of water works pumping engines. Their efficiency rating on trial was from 108 to 114 million foot-pounds duty. Their compactness, simplicity and freedom from the number of moving parts of the reciprocating type, as also their adaptability for working under variable loads, have shown them to be a very reliable type of water-works pumping engine. These pumps discharge the water through the force mains against the reservoir head and into the city's distribution system. There are six pumping force mains: one of the 36-in., two of 30-in., and three of 24-in. The others connect more directly and feed into the distributing service pipes throughout the city, as well as being indirectly connected with the reservoir. Thus the system may be said to be direct pumping with regulation of pressure due to the head from the reservoir of limited capacity.

The main reservoir, McTavish reservoir, situated at the head of McTavish Street on the slopes of Mount Royal, about 1½ mi. from the pumping station, has its water surface at elevation 204 above low-water level of the harbor. Its capacity is 37 million Imperial gallons, or about four-sevenths of last year's average daily consumption of 65 million Imperial gallons.

From the early settlements along the river front, the natural expansion of the city was towards the slopes of Mount Royal. In configuration, the city is laid out in main thoroughfares paralleling the river, the cross streets rising towards the mountain in gentle grades to the level of Sherbrooke Street, beyond which begins the slope of the mountain. The elevation of Sherbrooke Street at McTavish Street is 120 ft. above, and the distance some 6,000 ft. from the river.

The business or commercial section of the city lies principally in the lower levels of the city. The pressure head due to the McTavish reservoir supplies the system up to about elevation 130 above the harbor, furnishing water pressures of 80 lb. in the pipes of the down-town district to 35 lb. at the level of Sherbrooke Street.

High Level System

Above Sherbrooke Street and generally in that area spread out around the eastern slope of the mountain extends the high level system. The high level or Peel Street reservoir, situated on the mountain slope at the head of Peel Street has its water surface elevation at 422 ft. above the harbor. Its capacity is 1¾ million Imperial gallons. The high level system is supplied by repumping the water from the McTavish reservoir level. There are two pumping stations for this purpose: McTavish Street and Papineau Ave. stations. The pumping is done by high-lift centrifugal electrically-driven pumps, with two units, one of 6 and one of 5 million Imperial gallons in each station. The average daily consumption for 1919 of the high level system was 11.9 million Imperial gallons.

Upper Level System

To provide for water supply to the still higher residential districts of Cedar Ave. and Redpath Crescent, confined in area by the limits of Mount Royal Park, the upper level system was installed about nine years ago. This consists of a covered reservoir of 200,000 Imperial gallons' capacity hollowed out in the Mount Royal Park at elevation 550 above the harbor. The water is repumped from the high level system to this upper level by a duplicate set of electrically-driven units each of a capacity of 150,000 Imperial gallons per day.

To supply the high levels of Notre Dame de Grace ward, annexed to the city in 1910, there is also provided a booster pumping station on Western Ave. to repump the water from the main low level system. The pumping is done against the pressure head due to 3 tanks of 100,000 gal. capacity and

erected on the highest point in the ward at elevation 382 above the harbor. The daily average consumption is about 2½ million Imperial gallons.

The town of Cartierville, annexed in 1917, and forming part now of Ahuntsic-Bordeaux ward, has its own water supply plant of one million gallons' capacity, consisting of electrically-driven centrifugal pumps and filtration plant. This independent supply is taken from the back river at Cartierville.

The former town of Emard, annexed in 1910, and now part of St. Gabriel ward, has also an independent supply, the water being taken from the city's main supply conduit and pumped, under contract, by an outside company. The average daily consumption is about 935,000 Imperial gallons.

Water Distribution System

The city's distribution system of piping comprises 497.6 mi. of pipes from 4-in. to 36-in., as follows:—

Size.	Miles of pipe.	Percentage of total.
4	54.	10.85
6	63.	12.66
8	203.75	40.95
10	48.62	9.77
12	79.47	15.97
16	16.	3.21
20	3.55	0.71
24	16.6	3.34
30	9.55	1.92
36	3.06	0.62
	497.6	100.00

Of this total, it will be noted that the 8-in., 10-in., and 12-in pipe make up about 332 mi. or about two-thirds of the whole. For many years past the principle has been adopted that no pipe less than 8-in. diameter shall be laid for distribution service in the streets of the city. The mileage of 4-in. and 6-in. pipes shown in the table is mostly of piping in outside wards annexed to the city within the past ten years. The smaller pipes in the system are generally well supported at intersecting streets by pipe of larger diameter, especially in the main portion of the city, thus providing for several effective hose streams in case of fire without the use of fire engines.

Filtration Plant

In the city plant a double system of filtration is carried out, that is, the water is first passed through roughing prefilters before being passed through the regular filter sand beds. The raw water is taken from the main supply conduit through a 9-ft. circular conduit about 1,200 ft. from the lower end of the supply conduit, and is lifted by motor-driven low-lift pumps to the prefilters. There are 16 covered prefilters each of a net filtering area of 1,200 sq. ft. The water passes through the prefilters at a normal rate of 115 million Imperial gallons per acre per day. From the prefilters the water flows by gravity to the final filters There are 1 final filtered covered beds with a total area of 6 acres. The water passes through the final filters at a normal rate of about 8½ million Imperial gallons per acre per day, and collects in the covered filtered water reservoir which has a capacity of 6 million Imperial gallons.

The filter plant, as already stated, has a normal capacity of but 50 million Imperial gallons per day, and, as the water consumption has reached 65 to 70 millions, it is necessary to enlarge it, and plans are under way for this, the land being available for such extension.

Quality of the Water

The water drawn through the intake, 1,200 ft. from shore at the head of the Lachine rapids, is mainly of St. Lawrence River origin. However, as the Ottawa River joins the St. Lawrence at the head of Montreal Island, its waters follow the shore line inside the intake, and at times the supply contains varying proportions of Ottawa water, depending on seasonal and weather conditions. The largest percentage of Ottawa water occurs in May, and its presence is always indicated to the consumer by its characteristic brown color, but except in the months of April or May, when it carries a high turbidity, this is its only objectionable feature.

The water of the St. Lawrence, from the standpoint of household use, as tapped by the 1,200 ft. from shore intake, is superior in every respect to that found further inshore, and the bacterial content, turbidity and color increase as the shore is approached. The percentage of Ottawa water present in the city supply is indicated by the simple test, determining the alkalinity of the mixture in parts calcium carbonate per million.

The following tabulation of the physical and chemical characteristics of the water supplied during 1919 have been furnished by John H. Harrington, chemist of the water department:—

PHYSICAL CHARACTERISTICS, 1919

	High.	Low.	Aver.
Percentage Ottawa water	47 (May)	None (Feb.)	16
Turbidity	29 (Apr.)	7 (Feb.)	15
Color	38 (May)	6 (Feb.)	18
Bacteria per c.c., 96 hours at 20°—			
Raw	12,900 (Dec.)	320 (Aug.)	4,600
Chlorinated	57 (Mar.)	8 (Sep.)	19

CHEMICAL CHARACTERISTICS MONTHLY SUMMARIES, 1919

PARTS PER MILLION

	High (Feb.).	Low (May).	Aver.
(1) Total solids	150	110.2	124.5
(2) Alkalinity (calcium carbonate)	100	62	87
(3) Magnesium carbonate	6.0	4.6	5.5
(4) Sulphates and chlorides of calcium and magnesium	16.0	9.5	13.7
(5) Oxygen absorbed, organic and other oxidizable matter	3.5	9.0	5.5
(6) Chlorine (combined)	6.0	3.7	5.2
(7) Increase of total hardness due to addition of hypochlorite	1.2	0.24	0.70
(8) (7) expressed as % of (2)	2.0	0.24	0.80

Water Consumption

The accompanying diagram has been prepared, showing the average daily consumption of water for each year for the last 20 years, the population served, the per capita daily consumption for each year, and the area of the city served with water from the city system. The average daily consumption for 1919 was 65,046,000 Imperial gallons, and the estimated population served by the city's system was 449,000, a per capita daily consumption of 145 Imperial gallons.

In the years from 1900 to 1919 the average daily consumption increased from 20,412 millions to 65,046 millions, that is 44,634 million gallons, or 218% increase. In the same period the population served increased from 266,000 to 449,000, that is 183,000, equal to 69% increase. From 1900 to 1910 the average rate of yearly increase of consumption was 1,822 million gallons per day, an average of about 6.6% increase each year. From 1910 to 1914, the average yearly rate of increase was 4.27 million gallons per day, or an average increase each year of 9.6% over the preceding year.

In 1914-15-16 the rate of consumption remained stationary at about 55½ million gallons per day, but in 1917-18, for two years, it rose again at a rate of increase of 4.76 million gallons per day per year, and in 1918 and 1919 remained stationary at about 65 million gallons for each year.

The population served from 1912 to 1919 increased 110,000, that is, from 339,000 to 449,000, an increase of 32.6%. The consumption per capita between 1910 and 1914 jumped from 115½ gallons in 1910 to 150 gallons in 1914, and it has been between 140 and 150 practically since 1912.

It is difficult to explain this increased rate of consumption of water in the past ten years. It is no doubt partly due to more ample use of water in modern house fittings, but it may also be explained by the greater use in manufacturing establishments and the greater quantities required for

municipal purposes, public baths, parks and squares and the flushing of sewers and streets, all of which have greatly in creased in the past ten years.

Water Rates and Meters

The charge for water to the citizens is met by a municipal tax on all householders of 6% on the assessed rental. This tax is commonly called the water rates, but it does not necessarily represent the cost of the water service. The flat rate method of charging for water is not conducive to economy from the operating point of view. The citizens have no direct inducement to economize on water, and it calls for more rigid house to house inspection of fixtures if wastage is to be controlled.

Meters are placed only in certain commercial and manufacturing establishments, and other institutions where the use of water requires control against wastage. There are about 85,000 water services and only 1,668 meters in use; that is less than 2% of services are metered.

The meter rate regardless of the quantity of water used is $1.15 per 1,000 cu. ft., or about 18½ cents per 1,000 Imperial gallons. For fire protection, no charge is made for water used. The proprietor may install fire protection services of 4-in., 6-in., or 8-in. on his premises for sprinkler or stand pipes supply by paying the whole cost of laying the service, and excepting in certain manufacturing establishments which are all by meter, no charge is made for the water used for this service.

Projected Extensions

At present the city has under consideration many extensions to its water works plant. Two thirty-million-gallon electrically-driven pumps are contracted for to be delivered within a year. Plans are being prepared for enlarging the filtration plant to a capacity of 130 million gallons per day. To supplement the present limited conduit supply of 80 millions, the aqueduct is to be prepared for service to convey additional water and also to furnish power in a modified form. Additional reservoir capacity and increase in the number of force mains are also projected in the near future.

LONDON WATER WORKS EXTENSIONS HELD UP

COMMISSIONER PHILIP POCOCK, of London, Ont., declares that the London Water Works Act should be changed as soon as possible to permit the city system to expand proportionately to London's present and future growth. This act requires all surpluses in the water works department to be turned over to the city at the end of the year. Mr. Pocock believes that water works surpluses should be left in the department and thus make outside financing unnecessary. No more mains will be laid this year, or services installed because of a lack of funds.

Mr. Pocock states that London had lost a splendid opportunity in not developing the Komoka springs as a water supply. "They can be developed to-day," he stated, "but it would cost twice what it would have cost when first proposed. There are two million gallons available there of pure, spring water. A private corporation would have long since had them turned into London's water system, but we are held up by people who look on water rates as taxes when they are really commodity charges, and by an insistence that our surpluses be not used for natural development."

A resolution designed to assist shipbuilding yards in carrying out their contracts for vessels over 3,000 tons, has been placed on the order paper of the House of Commons in the name of Sir Henry Drayton, minister of finance. The resolution provides that the minister of finance may be authorized by the Governor-in-Council to endorse promissory notes drawn by the purchaser in favor of the shipbuilder for 50% of the purchase price where the remaining half of the cost has been provided for.

ADDRESS OF RETIRING PRESIDENT OF AMERICAN WATER WORKS ASSOCIATION*

By Carleton E. Davis
Chief of the Bureau of Water, Philadelphia

THE widest opportunity for this association, I feel, lies in a change in the relationship between the sections and the central organization. The sections must be developed, those already in existence must be strengthened, new sections must be created, all with a view of a final amalgamation in one central organization of the entire water works interests of the country. This process, carried to a logical end, will not destroy our existing organization, but, perhaps, change its character, opening up to it a much wider field of usefulness along somewhat different lines.

The American Water Works Association, when it adopted its name, expressed the intention to serve as this central body. The question before us today is whether we propose to grasp the opportunity to act or whether we shall let the opportunity pass us by. Acceptance of the present as we find it and committing the future to our successors is the easiest course. I believe our association will elect to follow the more difficult but more fruitful path.

Carleton E. Davis
Retiring President, American Water Works Association

The majority of our members are restrained in their activities by regulations imposed upon them by public service bodies, or by the restrictions of legislative enactments, or by the limitations of city laws and ordinances. Many of these restraints are irksome, and are not accepted calmly or without chafing under the restraint. Along the field of organization work we have a relatively free hand to organize and develop. We have an opportunity to demonstrate that the water works engineer and operator is a capable organizer, and, when given the opportunity, can conduct his own affairs with efficiency, and at the same time with due regard for the interests and welfare of the public, with an eye to the future and an alertness for the present. Necessary protests against undue outside restraint will come with much greater force if supported by the weight of a compact, comprehensive, well-organized and conducted association.

Predominant Importance of Water Works

It is stated on good authority that the investment in water works represents the largest total in the entire field of comparable utilities. Water works officials know that their plants, of all utilities, supply one universally indispensable commodity—vital for human existence and basic for all community life. We have common interests, and that we are grasping for methods of expressing this interest by working together for a common end is shown by the number of water

*Abstract of address delivered at the Montreal Convention of the Association, June 21st to 25th. 1920.

works organizations. The next step forward is the affiliation of the several organizations to handle matters of mutual interest with the power and weight that come from large numbers, unity of purpose and harmony of ideas.

Organization is the dominant note heard throughout engineering and allied fields at the present time. The American Water Works Association, through accredited representatives, recently attended a National Council in Washington of organizations concerned with public utilities like our own, seeking to co-operate, offensively and defensively, in matters vitally affecting the interests, personal and official, of their members. Whatever may be the final outcome of such efforts, or wahtever may be the path the council of affiliated societies may elect to follow, self-respect demands that the water works of the country shall be able to speak as a unit at such councils and with the weight attaching to full and not partial numbers.

Value of Comprehensive Organization

We are holding this convention in Canada, the home of a large number of our active, corporate and associate members. I feel confident that the further development of the principle underlying the sections will tend to stimulate Canadian interest in the same measure that I believe it will tend to awaken interest in other portions of the continent, irrespective of geographical location. Water works problems are physical and material, social and political. The first two mentioned are common, irrespective of locality. The last two mentioned depend upon the human element, and human nature has common characteristics the world over. Water works men on this continent have underlying interests and will continue to co-operate in the future as they have in the past.

We do not realize our strength because we have never attempted to exert it as a unit. Unorganized society is helpless against attacks and demands of relatively small but effective, because organized, groups working together. The existing lack of cohesion among water works men places them relatively in the position of the present unorganized public, powerful but helpless because of its inability to work together. Sometimes among our own ranks we hear references to the so-called little fellow and the big fellow. Each one of our members has something to give and something to receive. The perpetuation of the false idea of big and little, great and small, is harmful because it is based on wrong premises, is unreal and exists only in the imagination.

Water Works Men Must Take Initiative

The public water supplies of the country are developing from year to year, meeting the growth of the country. They present highly complex technical and engineering problems. The period of outside regulation has been with us for some time past and is increasing. Local, state and national health organizations are charged with functions relating to water supplies which are sometimes arbitrary and absolute. Public service commissions are given or assume increasing authority from year to year. Water works operators must determine for themselves whether they propose to accept, without a voice in the matter, standards which may be imposed upon them from the outside, or whether they propose to set up certain standards for themselves which outside bodies must of necessity accept because of the authority behind the conclusions of the water works operator. If the latter is to be the case, the water works men must take the initiative; otherwise it will be taken from them. If the water works men do not lead, they must follow.

Standards of practice and procedure must be done through committees and committee work will become of increasing importance. The path of the committees must be smoothed as much as possible. When the authority for committee work can emanate from a central body, representative of all the water works of the country, when co-operation comes logically and as a matter of course and not under option of possible rival organizations as at present, the desired end will be in sight.

LEGITIMATE USES OF WATER*

By George A. Johnson
Of Johnson & Benham, Consulting Engineers, New York and Kansas City

THIS general discussion on the legitimate uses of water naturally means that somebody is, or ought to be, about to say something concerning the wasteful habits of the inhabitants of the northern part of the western hemisphere. This need not be restricted to the mere waste of water; it can properly go further and include the waste which is evident in many localities in practically every department of municipal water works. Water waste is but a part of the story; the codicil to the will which bequeaths unwarranted extravagance.

Deputy Water Commissioner Liebenau of New York recently said that one-third of the water supplied to New York is being needlessly wasted. Recalling the remarks of Commissioner Galvin to the mayor, in his letter of resignation from the Board of Water Supply, that provision must be made at once for more water for Greater New York, even in the face of the fact that the new Catskill project is practically the newest baby in the public works house of New York, Mr. Liebenau's statement relative to water waste must necessarily lead a man with capacity for deductive thought to conclude that something is wrong with our methods. We go to great expense to increase the volume of our supply when for practically an insignificant sum we can conduct a water waste prevention campaign, as indeed New York is now doing, and perhaps so stave off the fateful day of water works extension until prices descend within reach of us, or the economic situation in the country is readjusted on a plane where supply and demand will balance.

Past Policy—Prudent or Wasteful?

Although the water works of the country in their several mechanical equipments show numerous straps and patches, conspicuous complaints over the lack of essential service, or prodigious conflagrations because of inadequate fire protection, are lacking. Is it possible that in the downily prosperous days of the past we replaced at high cost where we could just as well have repaired at small expense? Have we laid new mains, built storage reservoirs and installed new pumping units in order to obtain more water when we could have accomplished the same end effectively by searching out and stopping unnecessary waste of water, installing meters, cleaning mains to restore their original capacity, thereby cutting down friction losses and saving the coal pile and generally attending strictly to our job?

There seems to be real occasion for serious debate respecting whether the war period, and the manner in which we lived through it, has not furnished a lesson which most of us refuse to understand, namely, that it really is possible to get satisfactory service on a restricted program of water works extension, machinery replacement and the like, if we pay more attention to economy in all lines and exploit the more economical potentialities at hand to a far greater extent than we did before the war. It seems to be deplorably true that quite on the contrary, as an average proposition, we have followed the line of least resistance when the water consumption threatened to exceed the supply.

Actual Needs

It does not require 100 gallons of water daily to keep clean the epidermis and surroundings of the average American, carry away his sewage, cook his food and provide him with drink, or to furnish his share towards the water needs of the industries in his community. The New York water authorities seem to think that 80 gallons per capita is enough water for all the domestic, municipal and industrial needs of that city, and the speaker feels likewise. There

*From an address delivered before the Chemical and Bacteriological Section, American Water Works Convention, Montreal, June 25th, 1920.

seems to be no good reason why one city should hang up an actual water consumption record of 70 or 80 gallons per capita daily, and another of approximately the same size and industrial activity show a water consumption of three times that amount. And yet such occurrences are a matter of not uncommon record.

The speaker may perhaps be pardoned for referring again to the war period, for his experience in the management of the utilities in the army cantonments points a moral in the problem of water consumption. It is true that the use of water in these establishments was purely of a domestic character, yet the results were none the less striking.

What Watchfulness Did in the Army

The experience gained at these big military establishments showed positively what can be done with water supply systems hastily put together of any material most readily obtainable; with pipes of all conceivable sizes, practically regardless of what demands were to be placed upon them aside from the basic requirement that they pass water and enough of it; with motors often unsuited to pumping units and many other incongruities, all or almost all but the natural sequence of a program of unparalleled and urgently necessary construction. Coupled with structural idiosyncracies was the intense use to which these plants and systems were put during the war. Called upon to render service for which they were not built, overloaded much of the time, subjected to sudden and grave demand fluctuations, they were held together, maintained economically and made to function efficiently.

In the sixteen National Army cantonments, each housing an average of 38,000 troops and from 4,000 to 9,000 animals, with their sewerage systems, shower baths, flush tanks and all the modern conveniences for wasting water; with a soldiery, many of whom had never before seen running water except in brooks, manipulating compression cocks, the water consumption during the summer of 1918 (May to October, inclusive) was held to an average of 55.8 gallons per capita daily. Everybody had enough water, but waste was cut to a minimum by ceaseless and detailed inspection and watchfulness.

Extravagant Replacements

It seems clear that in the passed days of plenty we have lent ourselves too readily to the fascinating pastime of installing new machinery where old would do; to extend where the existing equipment, suitably improved, would answer for a period of years. In other words, is it not probable that the demand for building materials and equipment has been and still is far in excess of the real requirements, and that instead of encouraging economy we have practiced unnecessary extravagance where a little ingenuity and good management would have produced economically just as good results? It would seem so.

Preventive Measures

As an integral part of the program of conservation, water waste prevention is of cardinal importance. What can be done by intelligent and persistent effort in this direction is not so well understood as it should be, considering how long the salutary effects of such endeavors have been known to those who study the question. Nearly two thousand years ago Water Commissioner Frontinus of Rome took up the question of water waste in that city, and as a result was able to report, according to a translation of his writings by Clemens Herschel, "Whatever had been unlawfully drawn upon by the water men, or had been wasted as the result of official negligence, has been recovered. This is practically equivalent to the finding of new sources of supply. And in fact the supply was almost doubled."

Hazen, in his book "Meter Rates for Water Works," has discussed water wastage in a very attractive way. He says in part: "When a water-works system is first installed, all the plumbing fixtures in houses are new and they are in general reasonably tight; people will ordinarily draw only the amounts of water that they need, and waste is comparatively small in amount. As time goes on, rust, corrosion, the hardening of rubber valves, and other changes result in leakage from plumbing fixtures. Small leaks running constantly make little impression on people who do not realize their significance. Yet a leaky water closet may waste without attracting attention as much water as would supply twenty families.

"As time goes on people become accustomed to the waste of water in their houses and indifferent to it; and it is the experience of American cities where the meter system has not been used that the consumption always increases more rapidly than the population. It may be a long time before the output becomes double the legitimate use; but after that point is reached the rate goes on with greater acceleration until three-quarters of all the water that is furnished is wasted.

"The only limit to the increase is that a time comes when the new works required to supply the ever-increasing waste become so large and cost so much to build, that the burden cannot be further borne, and a better method is adopted."

What is needed now is action, and not discussion. If as water works men we are to do our appropriate part in untangling the financial snarl which involves the economic life of the world to-day, we can do no better than to bend our best efforts to cut down the illegitimate uses of water and reduce so far as is feasible expensive replacements and extensions. The former will long defer the necessity of developing new sources of supply, and the latter will develop to its utmost our engineering ingenuity. This will not be following the line of least resistance, but it assuredly will lead to material economy without risk of impairment of satisfactory service.

WATER SUPPLY STATISTICS FOR QUEBEC

By T. J. Lafreniere
Sanitary Engineer, Provincial Board of Health, Quebec

FIFTY-NINE per cent. of the population of the province of Quebec is served by water works, and the remaining 41% relies on shallow or tubular wells. The division is in close conformity with the statistics of population, the cities and towns forming 53.7% and the rural municipalities 46.3% of the total population. In detail, the distribution of inhabitants is as follows:—

18 cities	1,101,200
81 towns	178,400
220 villages	158,400
887 rural municipalities	942,000
Total	2,380,000

There are 440 water supplies in the province, but half of them are small, in some cases serving only a few houses. A special study of the water supplies of cities, towns and villages with a population of over 500 inhabitants, shows that there are 230 such municipalities, and 192 of them, with a combined population of 1,383,700, have water works. It is interesting to note in Table 1 how the various sources of supply have been utilized:—

TABLE 1—SOURCES OF WATER SUPPLIES IN QUEBEC

Source.	No. of works.	% of total number.	Population.	% of total population.
Rivers	97	50.5	1,192,512	86.2
Lakes	20	10.4	52,879	3.8
Springs or wells	75	39.1	138,338	10.0
Total	192	100.0	1,383,729	100.0

Eighty-six per cent. of this population is supplied with river water. This is a very high percentage, but it is due to the fact that with exception of four, all the cities use river water. When the water works were installed some 40 years ago, the rivers were fairly clean, and the necessity of pure

water was not as well understood as it is to-day. The towns were built on the shores of large rivers offering a supply of good appearance, and consequently the rivers were used in preference to more distant sources of supply.

The lakes, on the other hand, have not been fully utilized, when one considers that only 3.8% of the population is supplied by such a source. The numerous lakes all over the province offer a first-class supply, but, unfortunately, the lakes are not near the large centres of population. Twenty waterworks use lake water, but they serve mostly small towns.

The water-bearing formations in the province are not well known, and the available information on the subject is very meagre. Hence, 10% only of the population is supplied with underground water. With few exceptions, the 75 water works in this class, use springs originating at the outcrop of a porous stratum with an impervious one underneath. Such supplies are usually possible for small towns only. Several artesian wells have been sunk in the last few years, with remarkable success. The disadvantage of the source of supply is, that unless an extensive water-bearing formation is reached, the yield of the wells is uncertain and variable.

A great number of municipalities do not own their water supply, but with the exception of a part of the city of Montreal and two adjoining cities, this occurs in small towns and

TABLE 2—OWNERSHIP OF WATER SUPPLIES IN QUEBEC

Ownership.	No. of works.	% of total number.	Population.	% of total population.
Municipal	124	64.6	1,046,260	75.6
Private	68	35.4	337,469	24.4
Total	192	100.0	1,383,729	100.0

villages only. One municipality out of three, as will be seen from Table 2, does not own its water supply. The cost of water works is high, and after the construction of them, the small town finds that most of its borrowing power has been used by the water works, and that practically nothing is left for other improvements. Consequently, in order to have both, the water works and the necessary funds for other improvements, the municipality grants a franchise for the water works, which is a revenue-producing utility. This practice is not to be encouraged, as in most cases, the system does not provide for adequate fire protection, and eventually, the municipality has to buy the system and practically build it new.

Since the creation of a department of municipal affairs, the limit on borrowing power has been removed, but the necessary majority to sanction a by-law has been increased. Hence, it is hoped that the number of municipal water works will increase.

If we examine the use made of the various sources of supplies by the municipal or private corporation as indicated in Tables 3 and 4, we find that in both cases, over 85% of the population is supplied with river water. Two private water works only, use lake waters, while forty small supplies are derived from springs and wells:—

TABLE 3—SOURCES OF SUPPLY FOR MUNICIPAL WATER WORKS

Source.	No. of works.	% of total number.	Population.	% of total population.
Rivers	71	57.3	903,778	86.4
Lakes	18	14.5	49,929	4.8
Springs or wells	35	28.2	92,523	8.8
Total	124	100.0	1,046,260	100.0

TABLE 4—SOURCES OF SUPPLY FOR PRIVATE WATER WORKS

Source.	No. of works.	% of total number.	Population.	% of total population.
Rivers	26	38.2	288,734	85.5
Lakes	2	3.0	2,950	0.9
Springs or wells	40	58.8	45,745	13.6
Total	68	100.0	337,469	100.0

Although 86% of the population served by waterworks is supplied with river water, which is usually unsafe for domestic use, all of this water is not consumed without previous treatment. In the province to-day, 858,000 people are supplied with filtered river water and 170,000 with chlorinated water, giving a total of 1,028,000 people using treated water. This number represents 86% of the population using river water. Six municipalities, with a population of 60,000 people, now chlorinating their supply, have been ordered by the Superior Board of Health, to install purification works.

TABLE 5—TREATMENT OF RIVER WATERS

Treatment.	No. of installations.	Population served.
Filtration	29	860,000
Chlorination	15	170,000
No treatment	53	163,000
Total	97	1,193,000

Lake water and underground water being naturally good, it would seem that our water question is practically solved. Unhappily, this is not so. The great percentage of the population is protected against water-borne diseases, but the remaining 14% is divided among many small municipalities which will be harder to reach than the larger towns.

It appears from Table 5, that 53 towns, with a combined population of 163,000 inhabitants, use river water without any previous treatment. The streams from which these supplies are derived are more or less contaminated. Moreover, approximately 20% of the towns supplied by underground water have a supplementary water intake in a nearby stream, for fire purposes.

The Quebec Public Health Act of 1915 gives to the Superior Board of Health extensive powers concerning the control of water supplies. All new water works must be approved by the board before being installed. Furthermore, the board has the right to make investigations and to order purification works where needed, or to order the causes of pollution to be removed. When the supply is owned by a private corporation the Quebec Public Utilities' Commission decides whether the cost of the improvements shall be paid by the private corporation or by the municipality, and in what proportion. To comply with the orders of the board, the municipal corporation is allowed to borrow the necessary amount without being obliged to submit the by-law to its ratepayers, and the board has the right to have the improvements done at the expense of the municipality when the latter refuses to submit to the order.

But even with these extensive powers, the improvements necessary to the water supplies of the small towns above mentioned may not easily be obtained, because of the excessive cost of materials and the high rate of interest charged for municipal loans. The difficulty thus reduces to the financial question of how to obtain money for these small towns at a reasonable interest rate.

This difficulty the Board of Health hopes to overcome by means of a project, now under consideration, whereby small municipalities may borrow from the province, and at a low rate, the funds required for the needed improvements. If, as is expected, the legislature sanctions such a project, this most important remaining problem of water supplies in the province of Quebec—the problem of the small town supply—may be susceptible of solution.

A town planning committee is being formed in St. Catharines to co-operate with the Chamber of Commerce. It is proposed to divide the city into zones showing the possibility for expansion industrially. After that a systematic campaign will be started to bring new factories to St. Catharines.

The newly organized Water Board of Montreal, consisting of A. E. Doucet, W. J. Francis and R. S. Lea, consulting engineers, has completed its organization and is proceeding vigorously with its plans for the completion of the aqueduct, the construction of a new pumping plant, and the extension of the filtration plant.

War Burdens of Water Works Continue*

Advance in Labor and Material Costs—Gross Annual Revenue — Operating Expenses, Including Taxes — Net Annual Revenue — Municipally and Privately Owned Works— Taxes Paid by Privately Owned Works — Financial Outlook for Existing Works

By LEONARD METCALF
Of Metcalf and Eddy, Consulting Engineers, Boston, Mass.

THROUGH the courtesy of their managers it has been made possible to extend to January 1st, 1920, the data submitted in 1918 and 1919 to this association, upon the trend of prices in the water works construction and operating fields, based upon the actual experiences of about 50 water works in various parts of the United States, having a gross annual revenue of about $34,000,000 and serving an aggregate population of upwards of nine millions.

In the light of the burdensome increase in cost of living, even since the termination of the war by the declaration of the armistice, and the many evidences of profiteering in different fields and commodities, it is gratifying to be able to say that as a whole, and probably without substantial exceptions, the water works of this country have met their obligations to the public in a conscientious, effective and adequate manner and in spite of dangerous reduction in profit in almost all cases, and actual elimination in many.

Labor and Material Costs

Unskilled labor costs continued their advance during the year 1919 and are yet higher to-day. The percentage of increase in cost per hour over 1915 prices averaged about 80%—approximately 70% in the western and central groups of the United States and 90% in the eastern and southern. The average increase for the year 1919 over 1918 is about one-eighth.

While the efficiency of labor is probably slightly better than during the war period, it is still far below pre-war standards. It is conservative to say that taking productivity into consideration, as well as the price paid per hour, the cost of unskilled labor is more than double its pre-war cost.

Comparing the figures showing unskilled labor wages paid by water works in the vicinity of Boston, as of the end of March, 1920, with the records of a year earlier the nominal increase in rate per hour has been from 43.2c. to 50.6c.; the actual increase, including allowance for holidays and vacation leave, from 46.1c. to 56.7c. per hour,—21%. Fourteen out of 20 departments grant holiday leave under full pay, and seventeen out of 20, two weeks' vacation annually under pay.

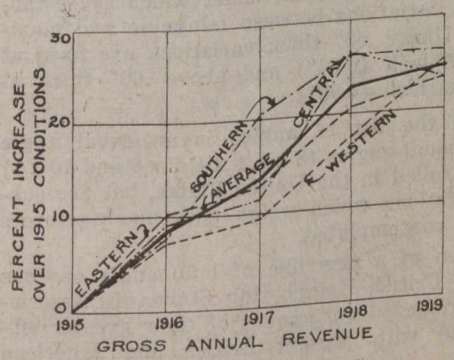


FIG. 1—VARIATION OF GROSS ANNUAL REVENUE

Cast iron pipe prices are to-day practically three times normal pre-war prices; the cost of valves and hydrants slightly less than double. Coal prices have receded somewhat, more nearly approaching the conditions of 1917 than 1918.

In Figs. 1, 2 and 3 are shown the gross annual revenue, operating expenses including taxes, and the net annual revenue applicable to depreciation, interest, dividends and surplus, of forty-six works arranged in four groups covering the eastern, central, southern and western sections of the United States. The per cent. increase over the conditions of the year 1915, are given, together with the average rate of increase applicable to the entire list.

From this record it appears that the gross annual revenue has increased in the years 1916 to 1919, inclusive, over 1915 conditions, progessively, by 8.5%, 13.5%, 22.7% and 24.5%. These amounts are all substantially below a normal rate of increase for such works.

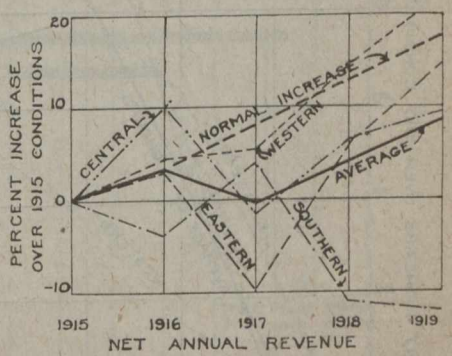


FIG. 2—VARIATION OF NET ANNUAL REVENUE

The operating expenses including taxes have increased progressively over the 1915 basis by approximately ⅛, ⅓, ½ and slightly over ½. The net revenue, without deduction for and therefore applicable to depreciation interest, dividends and surplus, has increased over the 1915 basis by 3.4%, 0.4%, 4% and 8.5%. This increase is less than half of what would be expected for such works in normal times. These figures indicate that in spite of the advances in rates, which have been granted in many places, the net revenue of the works is not adequate to command capital for their betterment over a long period of time. They indicate further, as will be seen from the diagram, that of the net burden resulting from war conditions about half has been borne by the works; the other half by the public which they serve.

Municipally and Privately Owned Works

A segregation of the records submitted, as between municipally and privately owned works, indicates that the increase in gross revenue for both of these has been approximately the same; that the increase in expenses has been more than twice as great for the privately owned group as for the municipally owned; and that the net revenue of the privately owned group has practically stood still while the municipally owned group has been increased approximately 40%. This comparison cannot be carried too far, however, as the list of municipally owned works is not sufficiently large to be thoroughly characteristic. Moreover, in the case of the municipally owned works the records of which are included, a much greater proportion have gravity supplies than in the case of the privately owned group. This has served to minimize the increase in expenses which would otherwise have been felt. It may be that the decrease in available labor during the war period, had a more material effect upon the municipal works than upon the private works and resulted in economies which would not have been possible in these public works under normal conditions. More important yet, it is to be observed that in the case of the municipal works substantially no taxes are paid, whereas in the privately owned group the taxes generally

*From a paper presented to the convention of the American Water Works Association, Montreal, June 21-25, 1920.

amount to about one-eighth of the entire gross revenue, and these taxes have, of course, been burdensomely increased since the war burdens began to make themselves felt. This influence is the most important one of those responsible for the comparative results referred to. As previously stated, however, limited weight only can be given to these comparative results of operation by municipally and privately owned water works.

Taxes Paid by Privately Owned Works

The analysis of taxes paid by privately owned water works shows interesting results. Excluding the returns from water works located in the state of Pennsylvania, because the basis of taxation is quite different there and incomparable with that prevailing in other states, it appears with respect to the privately owned water works that, under average conditions:—

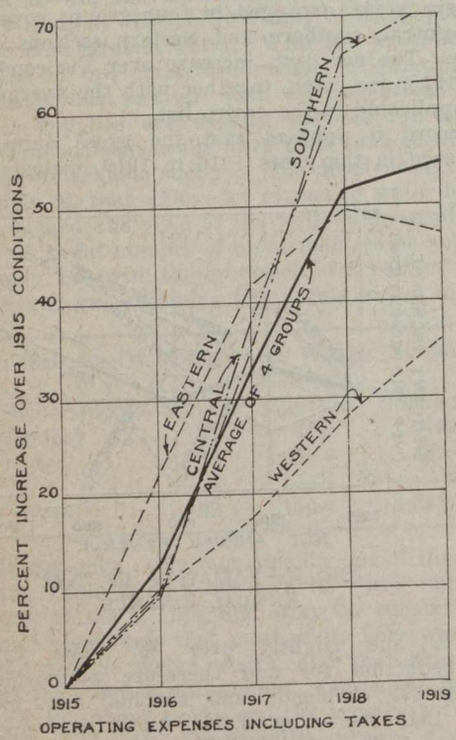


FIG. 3—VARIATION OF OPERATING EXPENSES, INCLUDING TAXES

1. One-eighth of their gross income is paid out in taxes;

2. The tax payments are equivalent to nearly 30% of the net income applicable to depreciation, interest, dividends and surplus;

3. The increase in taxes paid in the year 1919, over those paid in 1915, was 68%, or slightly over two-thirds;

4. The increase in the taxes paid in 1919 over those paid in 1915, constituted 27%, or slightly over one-fourth of the increase in the cost of operation (including taxes) of these works.

It is generally conceded that the summit of the high prices has been reached, where it has not been passed, and that, as to materials at least, and probably in lesser degree as to labor also, some recession in price is to be looked for. There is still, however, so marked a shortage of materials and labor, comparable with the demand, that construction costs are certain to remain high during the year 1920.

The financial outlook for existing water works is not encouraging. It is evident that the earnings during the war period have not been adequate to maintain the properties and pay a fair return upon their value. Such a condition cannot long continue without serious future embarrassment. The position that may be taken by the public service commissions or their regulatory authorities, will be reflected later in the character of the service rendered. If fair advance in rates be granted, first class service can be maintained. If this advance be retarded or be not adequate, a declining service must result. The increase in rates in the face of the present high cost of living will be very distasteful to the public and in some cases induce active opposition. Therefore, it is important that in making application for relief, the evidence should be clearly presented by the water works authorities, that the facts may speak for themselves and the difficulties of the commissions be minimized.

ANGLO-AMERICAN STANDARDIZATION OF STRUCTURAL SHAPES

DISCOVERING during the war that British standard sections of ship channels and bulb angles were peculiarly adapted to economical ship construction, the steel makers of the United States decided in 1918 to discontinue rolling American standard sections in order that they might compete on an even basis for ship steel at home or overseas. When the matter of revision of the British standards came up, the British Engineering Standards Association requested the co-operation of the American steel manufacturers, and, as a result, a sectional committee was organized under the auspices of the American Engineering Standards Committee to confer with the British organization.

This sectional committee gave very careful consideration to the entire routine of structural practice in the United States, not only as it affects the profiles of structural shapes themselves, but also in so far as it affects methods of order practice, calculation and publication of weights, areas, properties, etc., with the idea to insure as far as possible a complete accord between maker and users wherever the sections rolled in English-speaking lands were used. At its meeting held on April 27, 1920, the sectional committee formulated its recommendations for submission to its sponsor organizations—the American Engineering Standards Committee and the British Engineering Standards Association as a basis for common Anglo-American standards. Its conclusions are now to go before these organizations for further discussion and endorsement. The essential features of the recommendations are as follows:—

1. The adoption of the decimal system for the expression of dimensions, thicknesses and other elements of order practice.

2. The adoption as an Anglo-American standard of the standard order practice adopted by the Association of American Steel Manufacturers on February 20, 1920, under which structural shapes are to be ordered by weights per foot and not by thickness.

3. The adoption as an Anglo-American standard of American standard practice as it relates to ranges of thicknesses, methods of computation and methods of publication.

4. The adoption of definite ranges in thicknesses of angles and other structural shapes, under which are established two zones of variations between minimum and maximum thicknesses. Under .60″ thick variations are fixed at four one-hundredths inch (0.04″) and above .60″ thick at eight one-hundredths inch (0.08″).

5. Included in the list of angles is an equal angle (9 x 9) and four unequal angles (8 x 4, 9 x 4, 9 x 6 and 10 x 4) which are not now rolled in the United States, but are subject to the considerations which weigh with manufacturers when new rolls are contemplated.

6. The adoption of a new line of bulb angle sections as proposed by the British Engineering Standards Association that are recommended on account of their greater efficiency as compared with present British and American standards.

7. The adoption of a single line of channel sections with a 5° flange taper to displace the present two American lines, the structural line with its flange taper 9° 27′ 42″ and the shipbuilding line with its flange taper of 2°. This line of channel sections is not quite in accord with that proposed by the British Engineering Standards Association, but is believed to be more suitable to the requirements of the American trade and better proportioned.

8. The adoption of a new line of beam sections to take the place of the present American standards adopted in 1896. These sections have wider flanges than present American standards and do not agree very closely with the British proposals, but are believed by the sectional committee to be more nearly in accord with the recent developments in the fabrication of buildings and bridges.

Central Electric Station Industry in Canada

Analysis by Dominion Water Power Branch — Summary of Principal Features—Primary Power Equipment — Equipment Per Capita — Hydro-Electric Power — Employees, Salaries and Wages—Financial Statistics—Capital Invested in Hydro-Electric Systems

ELECTRICAL energy, through its ease of transmission and its broad adaptability to domestic, industrial and commercial use, has become of paramount importance in our modern life. The generation of electricity, dependent for the greater part upon coal and water power, has offered outstanding advantages to the efficient utilization of the latter, and Canada has been quick to appreciate the peculiar advantages possessed by her strategically-located water powers and to realize in their development for hydro-electrical purposes, one of her greatest natural resources. In this development the central electric station industry has played a most important part, and in view of its exceptionally rapid development, particularly during recent years, a record of its present standing is of special interest.

Scope of Analysis by Dominion Water Power Branch

The Dominion Water Power Branch, Department of the Interior, in co-operation with the Dominion Bureau of Statistics is publishing an analysis of the results of the second census of central electric stations in Canada, showing the status of this important industry at January 1st, 1919. The report includes statistics relative to central electric stations only, as defined for census purposes; i.e., stations which sell or distribute electrical energy for lighting, heating or general power purposes, other than that generated by industrial organizations for their own direct use in the operation of some other industry. The statistics, therefore, deal only with the generation and distribution of electrical energy in so far as such energy is not used directly by the station reporting. In each case where the central electric station operations are combined with those of some other industry, special care was taken to secure statistics relating only to

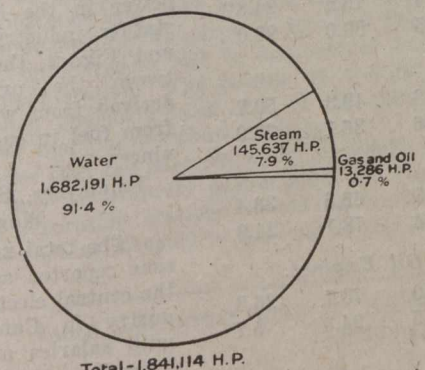


FIG. 1. *Central Electric Stations.—Primary Power by character of Power not including the 117,528 h.p. installed in auxiliary fuel plants 1918*

that part of the operations which are chargeable solely to the central station activities.

The central electric stations are divided into two fundamental classes; (a) generating stations, which include stations generating all or part of the power they sell or distribute, and (b) non-generating stations which purchase from some other station all the energy they sell or distribute. The analysis further divides the stations according to ownership and type of power used, into the following classes; municipal, commercial, hydro-electric power, and fuel power stations. The statistics are given for the Dominion as a whole, and by provinces. As the analysis has just been completed and some time must necessarily elapse before the report is ready for general distribution, the following brief summary of the statistics has been prepared.

The principal items reported, together with a comparison between the totals for commercial or privately-owned and municipal or publicly-owned stations are summarized in table 1. The total number of stations reporting is 795, of which 515 or 64.8% generate their own power, and 280 or 35.2% are of the non-generating type. The commercial stations numbered 377, and the municipal stations 418. Of the generating stations 332 are commercial and 183 municipal, while of the non-generating stations 45 are commercial and

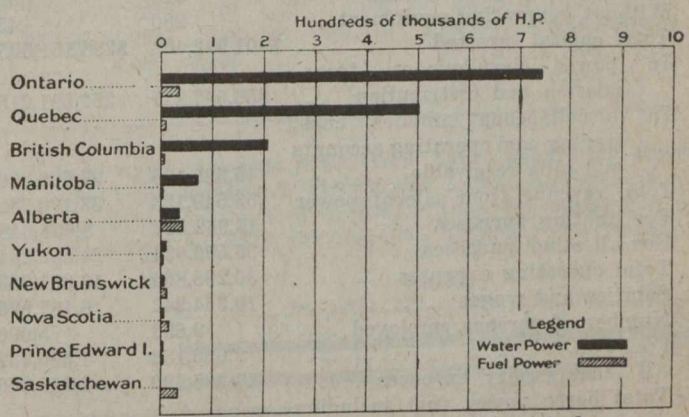


FIG. 2. *Central Electric Stations.—Water vs Fuel Power by Provinces not including the primary power equipment of auxiliary power plants 1918.*

235 municipal. As noted in the results of the last census the system of the Hydro-Electric Power Commission of Ontario with its extensive distribution, selling blocks of power to local municipal commissions, accounts for a large proportion of the municipal non-generating stations.

The aggregate capacity of all primary power machines reported is 1,958,642 h.p., of which 1,841,114 h.p. is installed in main plants and 117,528 h.p. in auxiliary or stand-by plants. Of the total for the main plants 1,434,196 h.p. or 77.9% was reported by commercial stations, and 406,918 h.p. or 22.1% by municipal stations, while of the auxiliary plant equipment, the former accounted for 110,853 h.p., and the latter 6,675 h.p. Table 2, presents by provinces, the total capacity of prime movers of different types and the dynamos installed in central electric stations. The figures are also given separately for main plants and for auxiliary or stand-by plants. According to source of power the total for all prime movers is divided as follows: From water, 1,682,191 h.p.; from steam, 262,562 h.p., and from gas and fuel oil, 13,889 h.p.

Power Equipment Per Capita

The relation of the installed primary power and dynamo capacity to population is given in table 3. The per capita analysis is given by provinces as this is the only feasible basis upon which such a comparison may be made in connection with the central electric station industry. Consideration of other elements, such as the varying density and the occupation of the population, will assist in a better understanding of the variations in the per capital development. The average primary power installation of the main plants per thousand population for the Dominion is 209 h.p.

The provincial averages on this basis are as follows:—Yukon, 1,135 h.p. per thousand population; British Columbia, 302 h.p.; Ontario, 277 h.p.; Quebec, 263 h.p.; Alberta, 129 h.p.; Manitoba, 121 h.p.; New Brunswick, 50 h.p.; Saskatche-

wan, 41 h.p.; Nova Scotia, 38 h.p., and Prince Edward Island, 14 h.p. It is notable that the highest averages on the per capita basis occur in the Yukon Territory, and the five provinces in which the greater proportion of the central electric station power is derived from water.

Hydro Power in Central Electric Station Industry

The extent of Canada's water power resources, their availability to industrial centres and their adaptability to the central electric station industry is reflected to a marked degree in the statistics presented in this report. Hydro-electric power is now served to practically every large industrial centre in Canada, and the rapid extension of the large distribution systems together with the active hydro-electric construction at present in progress is fast linking up the few centres which have hitherto derived their power from fuel. In considering the extent to which water is used as a source of primary power in this industry, it is of interest to note that according to a recent census of developed water power in the Dominion 72.7% of the total is utilized in connection with the central electric station industry.

Of the aggregate capacity of all prime movers installed in the main plants 1,682,191 h.p., or 91.4% is derived from water, and including the prime movers of auxiliary or stand-by fuel plants the hydraulic installation represents 85.0% of the total. The percentage of hydro-electric power in the various provinces is as follows:—Quebec, 98.4%; Yukon Territory, 97.8%; British Columbia, 97.2%; Manitoba, 95.5%; Ontario, 95.4%; Alberta, 42.9%; New Brunswick, 37.6%; Nova Scotia, 18.5%, and Prince Edward Island, 16.8%. Saskatchewan derives 100% of its central electric station energy from fuel. From this it will be seen that the first four provinces named and the Yukon Territory reported over 95% of their total central electric station power derived from water. With the completion of projected hydro-electric developments in Nova Scotia and New Brunswick the hydro-power percentages for these provinces will show a marked increase.

From Table 3 it will be noted that in Ontario, Quebec, British Columbia and Manitoba the steam plants which are auxiliary to hydro developments accounts for 113,350 h.p., or 69.2% of the total steam power installation for these provinces. It should also be noted that for the Dominion as a whole there is installed in connection with hydro-electric developments 117,198 h.p. in auxiliary fuel plants.

The results of the analysis of the primary power equipment are presented graphically in the accompanying diagrams 1 and 2. Fig. 1 illustrates the comparative importance of each of the three principal sources of primary power in the central-electric station industry in Canada, and Fig. 2, the relation between the primary power derived from water and that from fuel in each of the provinces.

Employees, Salaries and Wages

The total number of persons reported as employed in the central electric station industry in Canada is 9,696 with salaries and wages aggregating $10,354,242. Commercial stations employed 5,690 persons at $6,137,525, and municipal stations 4,006 persons at $4,216,717. The total number of persons employed in the industry averages 5.2 per thousand installed primary horse power, while the aggregate salaries give an average of $5.62 per installed primary horse power. In connection with the statistics of employees salaries and wages, it should be noted that in a considerable number of cases employees are engaged for only part of the time in connection with the central electric station operations, the balance of their time being charged to some other work not connected with his industry. This is particularly the case in non-generating municipal stations and in composite stations where the sale of electrical energy is only incidental to some other industrial activity. In instances of this kind only that part of the salaries or wages properly chargeable to the central station industry is recorded.

TABLE 1—CENTRAL ELECTRIC STATIONS:—SUMMARY OF PRINCIPAL FEATURES, AS AT JANUARY 1ST, 1919

Summary.	Total.	Commercial.	Municipal.	Per cent. of total, Commercial.	Per cent. of total, Municipal.
Number of stations	795	377	418	47.4	52.6
With generating equipment	515	332	183	64.5	35.5
Without generating equipment	280	45	235	16.1	83.9
Total capital invested	$401,942,402	$288,151,605	$113,790,797	71.7	28.3
In power development, transmission and distribution	356,547,217	250,591,215	105,956,002	70.3	29.7
In miscellaneous supplies, cash, trading and operating accounts and bills receivable	45,395,185	37,560,390	7,834,795	82.7	17.3
Total revenue from sale of power	53,549,133	33,190,882	20,358,251	62.0	38.0
For lighting purposes	16,952,512	8,638,648	8,313,864	51.0	49.0
For all other purposes	36,596,621	24,552,234	12,044,387	67.1	32.9
Total operating expenses	30,265,864	16,851,623	13,414,241	55.7	44.3
Salaries and wages	10,354,242	6,137,525	4,216,717	59.3	40.7
Number of persons employed	9,696	5,690	4,006	58.7	41.3
Fuel	2,626,132	1,505,732	1,120,400	57.4	42.6
All other sundry expenses	17,285,490	9,208,366	8,077,124	53.3	46.7
Total horse power (not including auxiliary plant equipment)	1,841,114	1,434,196	406,918	77.9	22.1
(1) Steam Engines and Steam Turbines.					
Number	255	141	114	55.3	44.7
Horse power	145,637	83,740	61,897	57.5	42.5
(2) Waterwheels and Turbines.					
Number	620	466	154	75.2	24.8
Horse power	1,682,191	1,345,656	336,535	80.0	20.0
(3) Gas and Oil Engines.					
Number	134	66	68	49.3	50.7
Horse power	13,286	4,800	8,486	36.1	63.9
Electric Generators.					
Number	990	659	331	66.6	33.4
K.v.a. capacity	1,433,722	1,118,438	315,284	78.1	21.9
Auxiliary Plants, Steam Engines and Steam Turbines, Gas and Oil Engines.					
Number	76	56	20	73.7	26.3
Horse power	117,528	110,853	6,675	94.3	5.7
Generators.					
Number	54	39	15	72.2	27.8
K.v.a. capacity	91,811	87,215	4,596	95.0	5.0

TABLE 2—CENTRAL ELECTRIC STATIONS:—SUMMARY OF TOTAL INSTALLED CAPACITY OF STATIONS INCLUDING—AUXILIARY STAND-BY PLANTS, BY KINDS OF MACHINES, AND BY PROVINCES—JANUARY 1ST, 1919

	PRIMARY POWER									DYNAMOS			
	Total Horse Power			Steam Engines and Turbines Total Horse Power		Gas and Oil Engines Total Horse Power				Total K. V. A. Capacity			
PROVINCES	Including Aux. Plant Equipment	Not Including Aux. Plant Equipment	Auxiliary Plant Equipment only	Including Aux. Plant Equipm't	Not Including Aux. Plant Equipm't	Aux. Plant Equipm't only	Including Aux. Plant Equipm't	Not Including Aux. Plant Equipm't	Aux plant equipm't only	Water Wheels and Turbines Total Horse Power	Including Aux. Plant Equipment	Not Including Aux. Plant Equipment	Aux. Plant Equipm't only
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Canada	1,958,642	1,841,114	117,528	262,562	145,637	116,925	13,889	13,286	603	1,682,191	1,525,533	1,433,722	91,811
Alberta	78,320	75,915	2,405	44,380	41,975	2,405	1,340	1,340	..	32,600	60,143	58,193	1,950
British Columbia	243,964	217,184	26,780	30,606	4,326	26,280	2,315	1,815	500	211,043	159,140	138,225	20,915
Manitoba	94,542	75,142	19,400	22,090	2,690	19,400	662	662	..	71,790	64,711	50,961	13,750
New Brunswick	19,063	18,563	500	11,010	10,510	500	1,075	1,075	..	6,978	12,836	12,836	....
Nova Scotia	20,315	19,565	750	16,481	15,811	670	220	140	80	3,614	18,691	18,235	456
Ontario	819,743	780,213	39,530	73,140	33,625	39,515	2,382	2,367	15	744,221	661,020	628,109	32,911
Prince Edward Island	1,353	1,353	.....	425	425	....	701	701	..	227	1,321	1,321	....
Quebec	639,907	611,744	28,163	37,895	9,740	28,155	294	286	8	601,718	514,296	492,467	21,829
Saskatchewan	31,215	31,215	.....	26,315	26,315	....	4,900	4,900	..	.....	27,195	27,195	....
Yukon	10,220	10,220	.....	220	220	....	....	....	..	10,000	6,180	6,180	....

Financial Statistics

A summary of the financial statistics for the Dominion is contained in table 1, while the provincial totals of the capital invested are given in table 4. In the latter table are also given the capital invested in hydro central electric stations and systems together with the investment per installed primary horse power.

For the Dominion the total capital invested in the industry was reported as $401,942,402, of which $356,547,217 represents the investment in power development and transmission and distribution systems, and $45,395,185 represents miscellaneous supplies and working capital. The commercial stations reported 71.7% of the total capital, and the municipal stations 28.3%.

The total revenue from the sale of electrical energy reported by all stations is $53,549,133, the commercial stations reporting 62% of this total, and the municipal stations 38%. This revenue includes the income received from the re-sale of energy purchased in bulk by one central station from another central station. The re-sale of energy by a second station must obviously take care of the purchase price of such power and the distribution charges.

In order that the part played by hydraulic power in this industry may be properly appreciated the capital invested in hydro generating stations should be considered in conjunction with that invested in stations of the non-generating type which purchase power from hydro generating stations. This combined data is given under column 8 of table 4. For the Dominion the total is $364,479,961, representing a total investment of $218 per installed turbine horse power, and accounting for 90.7% of the total capital invested in all central electric stations in Canada. As this capital includes investments in fuel power plants which are operated as auxiliaries to hydro-plants, the capacity of the primary power

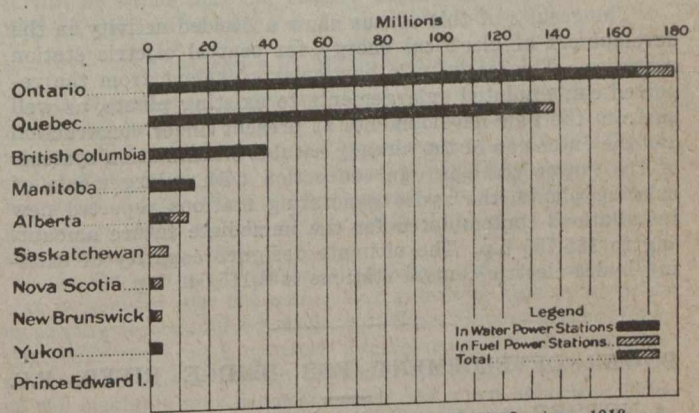


FIG. 3. *Central Electric Stations.—Capital Invested by Provinces, 1918.*

TABLE 3—CENTRAL ELECTRIC STATIONS:—RELATION OF PRIMARY POWER AND DYNAMO CAPACITY TO POPULATION BY PROVINCES, JANUARY 1ST, 1919

		NUMBER OF STATIONS			†PRIMARY POWER				†K.V.A. CAPACITY OF GENERATORS	
					Total Horse Power		Water Wheel or Turbine Horse Power		K.V.A.	
PROVINCES	Population	Total	Commercial	Municipal	Amount	H.P. per 1,000 Pop.	Amount	H.P. per 1,000 Pop.	Amount	per 1,000 Pop.
1	2	3	4	5	6	7	8	9	10	11
Canada	*8,835,000	795	377	418	1,841,114	209	1,682,191	190	1,433,722	162
Alberta	588,000	53	28	25	75,915	129	32,600	55	58,193	99
British Columbia	718,000	60	37	23	217,184	302	211,043	294	138,225	193
Manitoba	619,000	29	11	18	75,142	121	71,790	116	50,961	82
New Brunswick	369,000	25	16	9	18,563	50	6,978	19	12,836	35
Nova Scotia	519,000	39	25	14	19,565	38	3,614	7	18,235	35
Ontario	2,821,000	366	109	257	780,213	277	744,221	264	628,109	223
Prince Edward Island	94,000	9	9	..	1,353	14	227	2	1,321	14
Quebec	2,326,000	149	115	34	611,744	263	601,718	259	492,467	212
Saskatchewan	754,000	61	23	38	31,215	41	.....	..	27,195	36
Yukon	9,000	4	4	..	10,220	1,135	10,000	1,111	6,180	687

Notes:—*Includes population of North West Territories = 18,000.
†Power Equipment installed in auxiliary or stand-by plants is not included in this table.

TABLE 4—CENTRAL ELECTRIC STATIONS:—CAPITAL INVESTED IN CENTRAL ELECTRIC STATION INDUSTRY PER PRIMARY HORSE-POWER FOR ALL STATIONS AND FOR HYDRO-ELECTRIC STATIONS AND SYSTEMS

	ALL CENTRAL ELECTRIC STATIONS							Hydro Central Electric Stations and Non-Generating Stations which buy power in bulk from Hydro-Electric Generating Stations		
		Including Auxiliary Plant Equipment		Not Including Auxiliary Plant Equipm't						
PROVINCES	Total Capital Invested	Total Primary H.P.	Capital Invested Per H.P.	Total Primary H.P.	Capital Invested Per H.P.	Total Capital Invested in Commercial Stations	Total Capital Invested in Municipal Stations	Total Capital Invested	Total Turbine H.P.	Capital Invested Per Turbine H.P.
1	2	3	4	5	6	7	8	9	10	11
Canada	$401,942,402	1,958,642	$205	1,841,114	$218	$288,151,605	$113,790,797	$364,479,961	1,682,191	$218
Alberta	12,777,082	78,320	163	75,915	168	7,921,736	4,855,346	6,990,972	32,600	214
British Columbia ...	39,446,950	243,964	162	217,184	182	36,935,917	2,511,033	38,450,131	211,043	182
Manitoba	15,020,866	94,542	159	75,142	200	6,423,316	8,597,550	14,340,458	71,790	200
New Brunswick ...	3,564,542	19,063	187	18,563	192	3,059,111	505,431	1,303,727	6,978	187
Nova Scotia	3,977,311	20,315	196	19,565	203	3,196,188	781,123	797,122	3,614	221
Ontario	178,788,085	819,743	218	780,213	229	92,556,606	86,231,479	166,112,988	744,221	223
Prince Edward Island	403,761	1,353	298	1,353	298	403,761	.....	67,230	227	296
Quebec	138,374,304	639,907	216	611,744	226	133,895,147	4,479,157	132,945,655	601,718	221
Saskatchewan	6,083,198	31,215	195	31,215	195	253,520	5,829,678	.....	.....	...
Yukon	3,506,303	10,220	343	10,220	343	3,506,303	.....	3,471,678	10,000	347

machines of these plants added to the capacity of the hydraulic turbines gives a more logical basis for this analysis and reduces the capital investment per installed primary horse power for the hydro stations to $203. The capital invested in water and fuel power central electric stations is represented graphically in Fig. 3.

General Observations

The results of this census show a decided activity in the development of electrical energy for central electric station purposes. This activity is particularly evident from the reported contemplated enlargements to existing plants, as well as from the new developments at present under construction and the extension of the already notable transmission systems of the larger stations. In connection with enlargements of existing plants, the hydro generating stations reported new installations contemplated for the immediate future amounting to 135,755 h.p. The ultimate designed capacity of existing hydro-electric central stations is 2,115,043 h.p.

POWER DEVELOPMENT FOR BRIDGE RIVER, B.C.

ANOTHER step towards the development of the immense reservoir of power presented by the Bridge River, British Columbia, is the organization of an engineering party under W. R. Bonnycastle of Vancouver which is to leave immediately for Lillooet, the headquarters of the works. Men are already on the ground doing preliminary clearing.

The development of the power rights on the Bridge River calls for a tunnel two and a half miles in length under Mission Mountain, discharging on the shores of Seton Lake, about six miles from Lillooet. In that distance a fall of 1240 ft. is obtained and the total estimated horsepower has been set at 400,000, when the greatest available use is made of the water of Bridge River above the diversion. The plans of the interests behind the project have not been announced, but it is stated that they call for an eventual expenditure of $30,000,000 for the construction of six power units, to be placed in operation as conditions warrant at a cost of $5,000,000 each. The full scheme places the development among the biggest of its kind in the world.

The development is to be done by the Bridge River Power Co., the president of which is J. R. Read, Vancouver representative of the Canadian Westinghouse Co.

The committee of the Toronto branch of the Engineering Institute of Canada which, on the invitation of the City Architect of Toronto, has been for some time studying the proposed new city building by-law, is now practically ready to report.

DEFORESTATION AND BRIDGES

THE effect of the removal of the forest cover on watersheds is more widespread than is generally supposed. Not only is the snowfall allowed to melt more quickly and heavy rainfall permitted to reach the streams more rapidly, but in doing so it carries with it much lumbering waste and other forest debris. Such material causes serious jams, forming itself into closely-woven masses against the abutments and piers of bridges; the pressure of the water behind these jams carries away the bridges and their approaches, and floods much surrounding territory.

The rapid rise of the streams in response to the precipitate run-off also requires the provision of greater clearance between the abutments of bridges, whereas the tendency has been to reduce the spans, thus emphasizing the possibility of their destruction by freshets.

In this connection the experience of James W. MacKenzie, assistant road commissioner of Nova Scotia, is interesting. He says:—

"It seems to have been the custom for years, as wood became scarce, to narrow up and confine the streams in smaller vents. If it is a fact that the clearing of the country is the cause of the water running off suddenly in case of heavy downfalls, our bridges must be enlarged to carry the increased streams, and this has been my experience during the last twenty years.

"The most destructive summer freshet experienced in the counties of Antigonish and Pictou for the last twenty years, was the freshet of August 2nd, 1908. Some forty-six bridges in Antigonish county and fifty-six in Pictou were carried out, and in some sections every structure in wood was cleaned away. I took particular notice that, where the lumber trimmings had been thrown into the stream, the destruction was the greatest."—From "Conservation."

PUBLICATIONS RECEIVED

WROUGHT PIPE—Price List No. 3, of the Page-Hersey Iron, Tube & Lead Co., Ltd., Toronto. Paper; 4¼ by 7½ ins.; pp. 75; illustrated.

SMITH SIMPLEX PAVING MIXER—Bulletin No. 409A issued by the T. L. Smith Co., Old Colony Building, Chicago. Paper; 7½ by 11 ins.; pp. 20; illustrated.

DE LAVAL CENTRIFUGAL PUMPS FOR SUGAR HOUSE SERVICE—Issued by the De Laval Steam Turbine Co., Trenton, N.J. Paper 8½ by 11 ins.; pp. 8; illustrated.

CHRONOLOGY OF THE WAR, VOL. II., 1916, 1917—Issued under the auspices of the Ministry of Information, London: Constable & Co.; cloth; 5½ by 8¼ ins.; pp. 330; 7s. 6d.

MANUFACTURE OF ALUM BY THE MONTREAL WATER AND POWER CO.*

By Jas. O. Meadows
Sanitary Engineer, Montreal

SINCE all Hoover process alum plants are similar in general character, it is not intended to describe the plant of the Montreal Water & Power Co. in detail, but rather to give the experience of the past four years of operation. Descriptions in detail of the characteristic filter alum manufacturing plants of Columbus, Ohio; Springfield, Mass.; Trenton, N.J.; and Omaho, Neb., appeared in "Engineering News" of January 4th and 11th, 1917.

The alum plant of the Montreal Water & Power Co. was installed with the idea of keeping the capital outlay as low as possible consistent with proper operation, because at the time it was thought that such a plant would be used for only a comparatively short period of time. The plant consists of an acid storage tank, a dilute acid tank bauxite weighing hopper, Stedman mixer, and concrete crystallizing tray. No crusher is provided, the filter alum being broken up into lumps of suitable size by hand sledges.

Essentials of Manufacture

The manufacture of Hoover process filter alum is simple, but like every simple thing, there are several necessary conditions that need to be carried out to secure the product desired. By varying the temperature of the dilute acid, the character of the alum can be modified. During the winter months a porous alum is desired, because of its greater solubility, and this product can be obtained by mixing the bauxite with a low temperature acid. During the remainder of the year a filter alum of a more dense texture is secured by using a higher temperature acid. The temperature of the crystallizing tray floor is also a factor to be considered, and it is necessary to use a higher temperature acid for Monday's batch because of the lower temperature of the tray floor after the Sunday rest. The temperature of the acid is controlled by agitating with compressed air and with a cooling coil placed at the bottom of the lead-lined dilute acid tank. By using the air and cooling coil for different periods of time a dilute acid of the desired temperature can be obtained.

In securing a uniform product from day to day, care must be taken in having the acid strength uniform, the temperature variations slight, and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

Handling of Batches

A batch of alum (approximately 7,600-lb.) is made in five mixes using about one-fifth of the material for each mix, and the time consumed in mixing a batch of alum is about three-quarters of an hour. Greater speed in mixing could have been obtained if a mixing pan with a deeper pan and two agitators had been installed; also a better mixture of the bauxite and acid could have been obtained. The batch of alum is usually made early in the afternoon, and by next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ in. When the alum cake is to be removed from the tray, work is started at the alum dust ridge, as this point offers an easy place to pry the slabs of alum from the tray floor. The alum cake is removed from the floor with bars and picks and is broken up with hand sledges. The whole process, including carting to the storage floor above, consuming about six hours.

Cost Per Ton

Records of the alum making plant for the past two fiscal years ending May 1st last have been taken off, as during this period the cost of bauxite and acid have been rather constant, and it was thought that data covering this period would be fairly represenative of present conditions..

The cost of production for this two-year period is as follows:—

Bauxite and acid (including freight and cartage)	$45,961
Wages	4,220
Maintenance	1,490
Interest and depreciation—20%	2,400
Total	$54,071

During this two-year period 1888 tons of filter alum have been produced, making the cost work out at $28.64 per ton. The market price of commercial filter alum (including freight and duty) during this period has been about $55 per ton f.o.b., Montreal, and based on this figure the alum-making plant has shown a saving of slightly more than $49,000 for the two-year period. During this time, bauxite has cost approximately $24 per ton and 66° Baume sulphuric acid $26 per ton. At places where these two materials can be purchased at a lower figure the cost per ton for filter alum will also be correspondingly lower, because from the cost data presented it will be noted that the cost of bauxite and acid makes up 85% of the total cost.

Advantages of Manufacture at Site

In the manufacturing of filter alum at the point of consumption, freight, bagging and cartage is saved on the water, which makes up about 20 per cent. of the finished product. Experience over a considerable period has shown that the weight of the filter alum produced is practically the same as the combined weight of the materials that go to make up the product.

At the company's water purification plant the alum solution is pumped into the orifice box and from this point flows by gravity to the point of discharge. Since Hoover process filter alum has been used, greater depreciation of the solution pumps, valves, and fittings has taken place, due to the nature of the insoluble matter contained in the alum solution. This depreciation, however, has not been excessive, and has not run into an appreciable figure.

The manufacture of Hoover process filter alum has proved successful for the Montreal Water & Power Co. because of the saving effected. A further advantage is also gained as sulphuric acid is produced within a short radius of Montreal, and is easily obtainable, leaving only the bauxite to be secured from a distance. When secured, each ton of bauxite in storage represents about three tons of the finished product.

*Paper presented at annual convention of American Water Works Association, Montreal, June 21-25, 1920.

By the first of August the lignite briqueting plants established by the Research Council to fit for use the coals obtained at Souris, Man., and at Estevan, Sask., will be producing. It is expected that 30,000 tons will be produced this year at a cost much less than that of anthracite.

Although many tons of metal in the trusses of more than one-half of the entire roof surface of the train shed of the union station at St. John, N.B., collapsed on the evening of June 15th, only one person was injured. The collapse occurred while the roof was being demolished to make way for a new one.

The Ontario Cement Co. directors have issued instructions for the dismantling of the Blue Lake cement plant and its removal to Beachville at once. Additional land has been purchased at Beachville and sidings are being laid. Construction work will start as soon as the sidings are completed.

VARIATION IN CONSTRUCTION COSTS OF BUILDINGS

By J. T. Lawton
Wabana Mine, Newfoundland

ALTHOUGH two buildings may be of exactly the same size, and be built of practically the same material their costs will rarely be equal. For example, the miners' bungalows recently built for the Wabana mine on the same plan, of the same size, with the same number of rooms, windows and doors, and of the same material, show a material difference in cost.

Taking the highest priced bungalow as a standard of comparison, the others, as will be seen from Fig. 1, cost respectively 76%, 65%, 82%, and 70% of this one. The diagram submitted gives the approximate ratio of the variation in cost as deduced from the accounting sheets.

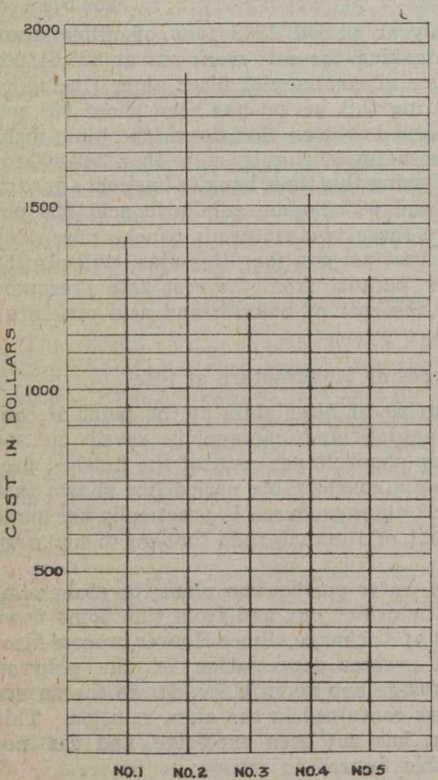


FIG. 1—VARIATION OF COST OF BUNGALOWS BUILT TO SAME PLAN

On examination of the records, the reasons for these differences in cost, may be classified under the following nine heads:—

(1) Carelessness of accountants having charge of delivery of material; (2) shortage of stock; (3) inferior quality of stock; (4) changes in class of workmen; (5) bad weather; (6) season of the year; (7) habits of workmen; (8) errors due to different departments handling different parts of the construction; (9) dishonesty of foremen.

A comparison of the various items of expenditure for each building will reveal many errors; as for instance, where a ten-window house is charged with only five windows. Such errors can be readily detected; but after allowances have been made for them, there will still be a difference, both in the amount of material used and in the labor cost, due to the factors already enumerated. A trustworthy estimate cannot therefore be deduced from the cost of one or two buildings; to be reliable, it must be an average of many such structures.

How Cost Factors Operate

The following is a brief resumé of the ways in which the factors already enumerated influence the construction costs:—

1. It often happens that the person in charge of stock neglects, or forgets, to charge up certain material. He may lose the order, or may charge it to a building or department for which it was not intended. The result is that although the stock may reach the building for which it was intended, the fact of it being charged to another building increases the cost of that building, while lessening the cost of the former. This is a matter which requires constant supervision and checking.

2. Shortage of stock necessarily implies an increase of construction costs. Under such a circumstance there is a slackening up of labor output, a marking of time, which means an increase of labor cost for a given amount of material used.

3. In the matter of inferior stock, there may be a wastage of fifty per cent. over the amount actually required. Knotty, badly-matched, or otherwise defective lumber, hardened cement, weathered bricks, sprung doors and sashes, help to run up costs of both labor and material.

4. It is scarcely necessary to state that labor costs will be influenced by the class of workmen employed. Some workmen have been known to do four times as much work in a given time as inferior men.

5. Bad weather increases the labor cost. Especially is this the case on outside work. It is difficult to estimate the ratio between the amount of work done in bad and in fine weather; but it is a well known fact that poor weather affects labor costs very considerably.

6. The season also influences costs. In December and January, the effective working day is reduced by an hour to an hour and a half. Workmen are nevertheless paid for full time. This necessarily increases the cost as compared with buildings erected in a more favorable season.

7. Local customs affect costs. In certain districts, workmen claim privileges established by long custom. Amongst these privileges, may be mentioned the "mug up" custom, which decreases the working day by an hour to an hour and a half.

8. Another factor causing differences in cost is the employment of highly paid men in cases of urgency. While the degree of skill which, say, a masonry job demands may be supplied by an ordinary bricklayer, the employment of highly paid men on that job would raise the comparative cost without any corresponding advantage.

9. A factor that must be taken into account is the dishonesty of foremen in marking time slips. In a large concern where the matter of keeping down costs is brought continually to the notice of foremen, and where one foreman's work is compared with that of another, an unscrupulous foreman will not hesitate to mark less men on the time slips than are actually employed on a job the cost of which he knows will be scrutinized. The time of the omitted men is charged up to an unimportant job. This fraudulent time-keeping is possible where a foreman has charge of several repair jobs.

An examination of all these factors shows that a contractor in making an estimate, has to have before him a varied array of costs, both of material and labor, and of their employment under varied circumstances before he can make an estimate that will be even approximate.

HYDRO-ELECTRIC STEAM RESERVE PLANT

TENDERS are being received by the Hydro-Electric Power Commission of Ontario for its proposed $7,000,000 steam generating plant to be located at Hamilton on the waterfront, near the steam power plant of the Dominion Power and Transmission Co. The plant will have an initial capacity of 50,000 h.p. and an ultimate capacity of 100,000 h.p. Time, as well as price, will be one of the deciding factors. If the commission decides to proceed with the work, every effort would be exerted to have 50,000 h.p. available within from ten to twelve months from the commencement of construction. That would be earlier than any energy could be secured from the Chippawa development with which to meet the shortage of power in the Niagara zone. The initial outlay for the 50,000 h.p. installation would be about $4,000,000.

The first club of the American Association of Engineers to be established in Canada is that at Levis, Quebec. J. O. Belanger is secretary.

COST-PLUS CONTRACTS FOR WATER WORKS CONSTRUCTION*

By George W. Fuller
Consulting Engineer, New York

PRIOR to the great war, the "cost-plus" form of payment on contracts in the water works field was limited to a relatively few large projects built as a whole under this type of contract for private corporations and to numerous small unexpected features of enterprises executed under municipal contracts where "extra work" clauses were attached to either lump-sum (bulk) or unit-price contracts. During the war a large amount of emergency government work which had to be performed in the shortest possible time gave great impetus to the "cost-plus" form of contract, or what the British call "prime-cost-plus-profit" type contract.

The unstable condition of the market for labor and materials now found in many places causes this form of handling construction work to come up repeatedly for discussion. Such discussion results from the necessity for finding expedients to meet present emergencies which, while not comparable with those of the war period, are nevertheless present during this reconstruction period to an extent which perhaps is not generally recognized.

At this time when contractors are sorely puzzled to know how to bid or tender on construction material on which quotations are made by dealers only on the basis of changes in price contingent on the actual date of future deliveries, and when labor is uncertain in quantity and of reduced and somewhat uncertain efficiency as to output of work per hour, it is obviously necessary to look conditions squarely in the face. Add to this the difficulties in transportation of construction materials and the loss incident to the contractor having a substantial payroll for labor when materials to work with are lacking, and it is readily seen that this is a time for considering fundamental principles in handling construction work to an extent that would not be of interest under normal conditions.

Reduced Construction Policy Advisable

The writer believes that water works construction which reasonably can be deferred should not be contracted for at present. In the case of many water works projects, the existing works can with propriety be patched and overhauled in a manner similar to that adopted by the individual who under present stress makes use of old and patched clothes. There are some water works betterments which cannot be postponed owing to the fact that this expedient has been resorted to for so long that further postponing means positive disaster along various lines associated with a water famine.

Much needed work is now impossible of accomplishment due to the inability of labor agencies to supply men, of manufacturers to supply material and of transportation facilities to deliver goods. Competition between owners will only increase the already serious aspect of obtaining material for construction work which it is important to have done in the near future.

Some water works construction must go forward. With conditions as they are at present, the contractor, if he bids on a lump-sum or unit price basis, is bound to name a price which, in his opinion, will protect him from loss, and if possible assure a reasonable return on his capital investment and for the work of himself and his organization. Under these circumstances it is important to discuss briefly the cost-plus form of contract with a view to seeing if the burden of uncertainty, in some respects, cannot be shifted from the contractor to the owner to the advantage of all concerned. In fact, if construction work is to go forward there are some projects where such steps seem imperative.

Before pointing out briefly the advantages and disadvantages of the cost-plus form of contract, it is well to recall that there is serious doubt as to the legal right of municipalities, in some localities at least, to enter into such contracts. State and provincial laws and municipal charters usually call for the letting of contracts for public works by open competitive bidding for all work in excess of certain specified amounts. Also, such laws provide, almost without exception, that contracts shall not be made in sums in excess of appropriations duly authorized and in some cases above the estimates of the engineer of the governing body.

As regards the first restriction the intent is obviously to take advantage of competition in making sure of proper market prices. The second restriction is a check on total estimated costs by actual bids for the work. In the absence of preliminary bidding, work might be started when appropriations are insufficient for completion, or opportunities might be lost for reducing costs by subsequent lettings through correction of misunderstandings as to construction procedures. Stabilization through such restrictions should not be abandoned unless there is a great emergency.

Cost-Plus Contracts

There have been and always will be certain construction problems in which some means of payment in the form of actual cost plus, a percentage or lump-sum is legitimate and desirable, if not necessary. This is true even with lump-sum contracts in which certain features may be indefinite or subject to changes regarding the character of the work. Cost-plus provisions for extra work, or supplementary contracts, based on such arrangements or estimates, are also pertinent where sufficient investigation previous to a letting is undesirable or too expensive in time or money for the advantage gained, such as extensive street openings to locate existing structures, and also in cases where the owner desires to retain complete control of the work regardless of the cost.

It is claimed that under the cost-plus method a contractor has little incentive to keep down the cost of the work. This is frequently true of the cost-plus-percentage but need not be true of the cost-plus-lump-sum type. In any case it must be remembered that a contractor who will deliberately be inefficient on a cost-plus project is equally sure to attempt improper or inadequate construction on lump-sum or unit-price agreements.

There have been a great many variations of the cost-plus contract applied to construction work, but the more important are:—

1. Actual proved cost with labor and material furnished without restriction by the contractor, plus a fixed percentage or lump sum to represent profit, supervision, financing, use of tools and plant, or any or all of these.
2. Actual proved cost of labor furnished by the contractor and with materials furnished by the owner, with a fixed percentage or lump sum as above.
3. Actual proved total cost for specified work plus a percentage for specified or unexpected extra or unforeseen work in connection with lump sum or unit price contracts.
4. Actual proved total cost to the contractor plus a sliding scale fee and upset maximum fee.
5. Actual proved total cost to the contractor plus a fixed plant charge and fixed construction fee.

Advantages of Cost-Plus Contracts

The following advantages are claimed for the cost-plus contract:—

1. The work may be started at any time and is not dependent on the prior completion of the plans.
2. The owner may radically increase or decrease the quantities during construction, with lump-sum fees subject to review.
3. The owner may change the kind of construction during the progress of the work.
4. The contractor will not try to skimp the job as is often done after finding himself losing under lump-sum or unit-price contracts.
5. There is less need of having accurate preliminary estimates. In unit-price contracts the preliminary estimate

*Paper read before the American Water Works Association at Montreal, June 24th, 1920.

is often so approximate as to cause the contractor to gamble on some of the items, with resulting disappointment to the owner in the ultimate cost of the work. Such procedures sometimes cause an unfair result either to owner or contractor or both.

6. Unit-price or lump-sum bids require a set of specification definitions which are not always clear and are sometimes deficient, sometimes overlapping. Such ambiguities may lead to arguments and variations in cost which result in claims and suits for extra work.

7. Cost-plus contractors may save the owner the money which the contractor usually adds to his lump-sum or unit-price bid to cover the complete but actually infrequent enforcement of material tests which cause him delay and expense, or necessitate the carrying of a large stock, entailing interest charges, storage space, rehandling, etc.

8. Cost-plus contracts do away with the substantial sums usually added in lump-sum or unit-price contracts to cover the following uncertainties: (a) Weather; (b) foundations; (c) changes and shortages in labor market; (d) changes and shortages in material market; (e) delayed deliveries of materials.

9. For cost-plus work, it is the contract and not the specifications which is the crux of the matter from both the owner's and contractor's viewpoint. The writing of the contract is more simple than the writing of the specifications.

10. Cost-plus contracts tend to promote co-operation between the owner and the contractor.

Disadvantages of Cost-Plus Contracts

The disadvantages of the cost-plus contract may be stated as follows:—

1. There is no way of determining the approximate cost in advance and this upsets budgets where definite appropriations have been made or are required.

2. Competition, the key to efficiency, is killed.

3. Greater opportunity is offered for favoritism on the part of the owner's representative.

4. Where the same contractor has several jobs, the lump-sum and unit-price contracts will get the good workmen and the cost-plus contract will get the drones and misfits.

5. A large general contractor often takes a job on the cost-plus basis and sublets it to several smaller contractors on a lump-sum or unit-price basis. In making the sub-contractors complete the work on the latter basis, the general contractor often treats them unfairly while he himself may be receiving a substantial profit for doing little or nothing.

6. Should work be started before plans are completed, many errors may have to be straightened out in cases where competent engineers would avoid them if given an opportunity to get out a complete set of plans and accurate estimates of quantities.

7. Engineers are tempted to be less thorough in their work when they know that there will be no comeback at them on account of extras resulting from their failure to have plans and specifications complete when needed. With cost-plus contracts it may simply be a matter of correcting an error or supplying a deficiency when discovered, but the cost is there just the same, although it may not appear as an "extra."

8. Engineers or other representatives of the owner must do an immense amount of accounting and clerical work in checking payrolls, material bills, etc., and expend much time and energy in expediting the delivery of materials.

9. A premium may be put on extravagances and waste by giving unscrupulous contractors and engineers a chance to take advantage of the owner.

10. The contractor may procrastinate in securing if not refuse to secure promptly adequate tools and equipment as to type and number.

11. A combination of the above disadvantages, although no one by itself may be sufficiently pronounced to permit the owner successfully to obtain relief, may cause brief for the owner, unless protected by a maximum fee to the contractor, and by the assured adequacy of the latter's organization and equipment.

Much large construction work was and is done by railroads and other corporations, in this way, but this is done usually because the corporation, unlike municipalities, are legally able to select competent contractors with efficient organizations and equipment to work under the immediate direction of a skilled and alert staff of the owner, who for the most part purchases supplies and materials direct. The Grand Central Terminal in New York is a case in point. Much of the work was first awarded to a contractor on a unit-price contract but it was completed under a cost-plus agreement.

There can be no question that some work can be as economically and efficiently done under the cost-plus basis as in other ways. But in the water works field such work appears to form the exception rather than the rule under peace time conditions.

Army Contracts for Construction Work

One of the best examples of cost-plus-percentage agreements is found in the United States army construction work during 1917-18. Here the contract was on what is known as the "cost-plus-a-sliding-scale-fee" with a maximum upset fee.

Overhead expenses and interest costs reduced the actual profit to most cantonment contractors to less than one and one-half per cent. In this case the specified cost of the work included all payments of whatever nature with the exception of overhead costs of the contractor including financing expenses.

The union scale of wages prevailing in the locality of the work under consideration, as of June 1, 1917, was agreed upon by the Secretary of War and the President of the American Federation of Labor as the scale for the camp. Rules in reference to overtime, and for the regulation of hours of work, were agreed upon in advance between the constructing quartermaster and the contractor, in accordance with conditions prevailing in the district where the work was done.

The question of whether or not the government got a fair return in its investment depended largely on the adequacy of the auditing and checking system which the constructing quartermaster carried out on the job. There is no room for doubt as to the wisdom of the U. S. military establishment having acted wisely in adopting the cost-plus form of contract for its emergency work. Speed was of vital importance. Abnormally high speed always means abnormally high cost. But in this war emergency abnormal construction costs were of no significance as compared with the saving in blood and general war cost which resulted from such construction speed. In this connection it is well to recall that the government through priority arrangements had the benefits arising from the commandeering not only of materials and of labor but also of transportation. Such benefits do not attach to peace time work in any field.

General Considerations Regarding Contract Work

On contract work engineers should not be compelled to do the work of both the engineer and the contractor, because contractors should be more capable than owners or their representatives to handle advantageously and economically the details of construction requirements. Contracts should therefore be drawn in such a manner as not to limit the work and responsibility of the contractor to the furnishing of labor and to the execution of details under the absolute direction of the owner and his engineer. Responsibilitity for good construction and final excellency of the work should rest with the contractor.

To insure satisfactory results from cost-plus-lump-sum agreements, the contracts should provide for the reimbursement of the contractor for all amounts actually spent by him, such expenditures being limited in the case of materials to their normal market value, and for labor to price schedules of local labor unions. The lump-sum fee allowance should include the services of the works superintendent and

hand tools and such small equipment as would obviously be required for the work. For plant equipment such as machine tools, excavators, cable ways, etc., a per diem rental under stipulated conditions should be fixed or bids should be received. To prevent disputes the plans and specifications should be as carefully prepared as for other types of contract.

Good examples of cost-plus-lump-sum agreements are found in the U. S. Housing Bureau and other government contracts which provide for a rental price for plant equipment and a contractor's fee for services, on all of which bids were taken from a list of acceptable contractors.

The plant equipment fee covered the rental of all machinery, scrapers, scaffolding and tools, and all material which did not enter into permanent work. It did not include, however, lumber for temporary forms, concrete centering or the bracing and supporting of these forms or light staging or scaffolding on the exterior of structures.

The contractor from his fee was obliged to pay all costs of transporting, loading and unloading the plant equipment, and all upkeep and maintenance charges, fuel, oil, office overhead and general superintendence. A bonus was allowed the contractor, in addition to the lump-sum fee which he bid, in the amount of one-fourth of any saving he was able to make as compared with his accepted estimated cost of the total work.

Under this agreement the contractor financed the entire construction work and was reimbursed by the owner for all such cost. A very strict system of inspection and accounting was maintained by the government.

Profit sharing methods have considerable merit over the straight cost-plus forms, in that they give the contractor some incentive to keep the cost of the work down. A method which has been used with considerable success in Canada is described by R. O. L. French. By its terms the contratcor receives 20% of the estimated cost and rebates to the owner 10% of the acutal cost.

Contract Adjusted to Varying Labor Prices

Morris R. Sherrerd, chief engineer of the North Jersey District Water Supply Commission, in a recent contract for the construction of the Wanaque dam, provided for an adjustment of certain labor costs after the year 1920, provided such costs are 10% above or below normal 1920 prices. This places the burden of changes in material costs on the contractor, but causes the owners to share with the contractor unusual changes in labor costs. The advantage of this type of contract as to labor over cost-plus agreements lies in the fact that the contractor is compelled to exercise the same careful supervision and that there is the same necessity for economical construction methods as is required on lump-sum and unit-price agreements, but he is not obliged to shoulder all responsibility for unexpected price changes.

In the Wanaque dam contract, labor is a controlling item, but on ordinary construction work, particularly on comparatively small jobs, and where the value of labor and material are more nearly equal, there would be less advantage in it. To be more generally applicable the adjustment in prices should if possible include material as well as labor, and furthermore the length of time between successive adjustments should also be made to conform to the size of the contract and to the probable duration of construction.

The adjustment of prices is more difficult in the case of materials than for labor, because of the greater number of materials and also because of the variety of materials which might satisfy any particular specification. On this account the furnishing of the principal materials to the general contractor through separate contracts made by the owner may be advantageous in that the risk would be more widely distributed and the adjustment of prices made somewhat more simple and definite.

At a time when transportation facilities are abnormally inadequate the assumption by the owner of the responsibility of furnishing materials cannot eliminate wholly the troubles arising from the enforcement intermittent use of the contractor's laborers.

Summary and Conclusions

1. Pre-war construction contracts were for the most part, and rightly so, agreements on a lump-sum or a unit-price basis. Cost-plus contracts were used only on certain large work done for private corporations or as a part of other types of agreements.

2. During the war the United States government construction and much other work was done on a cost-plus basis. Where proposals on a lump-sum or unit-price basis were obtained, the prices were intended to be sufficiently high to insure against loss due to constantly changing prices and the scarcity of labor and material.

3. Since the war, the procedure has been somewhat unsettled, with an effort to do away with some of the disadvantages of cost-plus form and to combine so far as possible the good qualities of both types of contracts.

4. The unit-price contract under normal stable market and transportation conditions is the most satisfactory. The lump-sum contract is principally advantageous in that the final cost is definitely known at the outset.

5. Cost-plus contracts, with proper provision for accounting and supervision, may be satisfactory where conditions are not definitely known, and in the case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions cost-plus contracts were necessary and even now have many advantages.

6. Construction work for private corporations may be successfully carried out with proper safeguards under any of the discussed forms of contract. For general construction work under municipal control, the nearer a contract approaches the well-established lump-sum or unit-price contract, if indeed any departure from such contracts is legal, the more satisfactory will be the results secured.

7. Until such time, however, as the material and labor markets are better stabilized, contracts should in fairness place the burden of uncertainty on the owner and not on the contractor. This may be done as follows:—

(a) For much municipal work, a form of contract may be adopted along the lines proposed by Mr. Sherrerd, and modified as suggested as to labor and material adjustments at proper intervals.

(b) For municipal or other work contracts may provide for the furnishing by the contractor of such labor and materials as are reasonably stable, with adjustment for changes in the labor market, and with materials of unstable price furnished by the owner through separate contracts.

8. Construction work not absolutely necessary should be deferred, and materials and labor should be diverted so far as possible to work which is absolutely necessary.

9. So far as possible necessary improvements should be made by repairing or enlarging present works, and new works should be confined for the present to immediate needs.

The inaugural convention of the Trent Waterway Development Association was held at Peterboro, on June 15th, in the form of a banquet. It was one of the largest gatherings of Trent Valley interests ever held in this district, and was marked by general enthusiasm and confidence in the future of the Trent Canal.

It has been unofficially reported from Ottawa that if the Hydro-Electric Commission of Ontario wants to secure the radial lines in the province which were taken over as subsidiaries when the government bought the Canadian Northern, it may have them at cost. The lines in question are the Toronto, Niagara & St. Catharines, the Toronto Suburban, and the Toronto Eastern.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

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

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

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

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

THE NIAGARA OFFENSIVE AGAINST INDUSTRY

IF the consumers of power in central Ontario are forced to pay in perpetuity a price for hydro-electric energy that leaves them hopelessly outdistanced by those not dependent upon Niagara, they will, to a very great extent, have the Niagara District Trades Federation to thank for it. It is already evident that power from the Chippawa development will cost delivered, not seven or eight dollars per horse-power, as originally expected, but at least twelve dollars per horse-power. The double walk-out at Niagara is not the doing of suffering toilers, starved, underpaid and driven to a last act of desperation against heartless and inconsiderate magnates. There is no hardship. The men are paid at rates that compare favorably with those paid on work of the same class elsewhere. The housing conditions are satisfactory. Board and lodging is provided at the camps for $7.70 a week, but little more than a laborer earns in one day. For the work of heavy construction the laboring conditions could scarcely be better. And yet labor refuses to continue.

Those who direct labor policies in the Niagara peninsula can present no proof of privation. The laborer who rejects $1,391 a year does not do so because it is insufficient for the maintenance of himself and his family, nor is $3,086 a starvation wage for a drag-line operator. The truth of the matter is, that reason has altogether forsaken labor along the Chippawa canal. Labor knew of the desperate race to complete the development by August 21st, 1921. It had profited by the desire of the Hydro-Electric Commission to carry out the great work on schedule to the extent of exacting high toll last year. This year it thought it could do so again. The eight-hour day was introduced in May to placate labor: half the men struck for a ten-hour day. In June the commission conceded a ten-hour day: the rest of them struck. There is no remedy for the situation in the present temper of labor but to close down and stay closed until some semblance of sanity returns to those who are balking the commission in its effort to give cheap power to this province. If a year hence employment in Ontario is scarce and insecure, due to handicapped industry, it is to be hoped that the Niagara District Trades Federation will recognize its own brigandage.

THE BRITISH ENGINEER AND RECONSTRUCTION

WITH the adaptability and resourcefulness that characterized him in war, the British engineer is turning to the technical problems of reconstruction. Already, great numbers of shops that in war-time were entirely devoted to the manufacture of munitions are now given over to peaceful pursuits. In many others, such structural alterations are under way as will give competitive manufacture a firm basis. Several shops erected during the war for the manufacture of guns has been adapted to the building of locomotives.

In house construction, radical departures have been made to meet the pressing demand. A large industrial company in the north of England has recently developed, in connection with a housing scheme, a system of construction involving the use of a steel skeleton covered with a reinforced concrete shell. Extraordinary difficulties have been met by unthought of solutions.

There is evidence of great industrial activity and of the will to regain and hold the pre-war commercial ascendancy. Many industrial research associations have been formed and are working in conjunction with the department of Scientific and Industrial Research with the expenses of the research met partly by the industries concerned and partly from state funds. Co-operative work of this kind has not, however, discouraged private enterprise in research. Many firms are extending their research laboratories and prizes are being offered for success in special directions. The Air Ministry has offered valuable prizes for the development of aircraft design and construction. Shipbuilding is forging forward. Lloyd's returns for the quarter ending March 31st, 1920, show that Great Britain has regained its lead as the world's greatest shipbuidling nation. The tonnage under construction in Great Britain exceeds that of the United States by over 800,000 tons. New British vessels put in hand during the quarter numbered 229 and aggregated nearly 710,000 tons.

With the British engineer turning his attention to the problems of reconstruction as whole-heartedly as he did to those of war, national recovery from the consequences of the long struggle should be assured.

GOOD OUTLOOK FOR HYDRO RADIALS

CONCURRENCE in the plans and estimates prepared by the engineering staff of the Hydro-Electric Power Commission of Ontario for the Hydro Radials is the burden of the report recently submitted to the Commission by W. S. Murray, consulting engineer, of New York City.

Mr. Murray was directed to make a comprehensive survey of the whole situation respecting the proposed Hydro-Electric radial railways between Bowmanville and Toronto; Toronto, Hamilton and Niagara Falls; and Hamilton, Galt, Guelph and Elmira. He went thoroughly over the ground in connection with the three projected radials and reported substantially as follows:—

(1) The construction and operating estimates made by the Hydro-Electric engineering staff are conservative.

(2) The lines are admirably located with reference to the passenger and goods traffic they are designed to reach, the density of which is not in unfavorable comparison to the existing roads which have thrived in the states.

(3) The act of their construction is not one against which a charge of duplication can be made.

(4) It is inadvisable to proceed at this time with the full construction of these radials on account of the greatly inflated costs applying both to line and equipment.

(5) It is most important, however, that the commission proceed with the development of its full plans applying to financing as well as construction, in order that it may be in a position to acquire such existing radials and property as may be economically purchased, and which will later form parts of the completed systems.

Dealing with estimated costs, Mr. Murray figures for the roadbed, right-of-way, overhead equipment, etc., on the Toronto-Niagara Falls line a total of $17,498,635. In the matter of rolling stock he points out that a very considerable rise in cost has taken place, and he places the cost at $4,800,000 instead of $4,150,000 allowed in the revised estimates of the Hydro-Electric Commission. He feels, therefore, that a total of $22,298,635 would be a conservative estimate for the line.

For the traffic investigation, Mr. Murray consulted J. K. Punderford, vice-president of the Connecticut Company, a corporation that owns and operates practically all the urban and interurban railway lines in the state of Connecticut. Mr. Punderford supports Mr. Murray in the opinion that the income estimated by the commission, namely, $2,500,000 per annum, is justified. This practically equals the total annual costs figured at present abnormal levels, exclusive of depreciation of equipment, sinking fund or the use of the Grand Trunk property at Hamilton.

It should be reassuring to the people of the province of Ontario to find the plans and estimates prepared by the engineering staff of the Commission strongly upheld by an outside and impartial engineer of the eminence of Mr Murray. Verification of the Commission's work in this respect should make its course easier in others.

PERSONALS

J. F. WRIGHT, Canadian Geological Survey, Ottawa, and N. A. MCINTOSH, Queen's University, Kingston, are making a detailed geological map of the Brockville area.

ROMEO MORRISSETTE has resigned his position with the department of public works, Canada, to accept one with the National Shipbuilding Corporation, Three Rivers, Que.

J. G. STEPHENSON, of Paynton, Sask., is to be resident architect for the federal department of public works in the province of Saskatchewan, with headquarters at Regina.

JAMES BAIN, mechanical and electrical superintendent for the works department of Hamilton, Ont., has been named by the board of control as mechancial engineer for the city.

F. R. EWART, of Ewart, Jacob and Byam, consulting engineers, Toronto, has been appointed a member of the board of conciliation which will investigate the dispute between the Toronto Hydro-Electric Power Commission and its electricial workers.

DR. JOHN A. DRESSER, consulting geologist, of Montreal will head a party including PROF. ALEX. MACLEAN, University of Toronto, and EDMUND SPEAKER, of the department of geology, John Hopkins University, Baltimore, Md., to investigate the possibilities of the Peace River district.

CHARLES TAYLOR has been appointed to take charge of the Ontario business of W. I. Bishop, Ltd., engineering contractors of Montreal, with offices at 32 Front St. West, Toronto. Mr. Taylor is well known throughout Ontario in construction circles having been engaged in erecting completly equipped industrial plants for a number of years, specializing in reinforced concrete structures.

PROF. A. T. LAING, who is in charge of the course in highway engineering at the University of Toronto, has been engaged by the department of highways of Ontario to make a special investigation of automible headlights in connection with the new non-glare headlight law that is to come into effect in a few weeks. Prof. Laing will make a thorough enquiry into present practice with respect to headlights both in Canada and the United States and will draft regulations and specifications for their control.

ARTHUR SURVEYER, who was recently elected chairman of the Montreal Branch of the Engineering Institute of Canada, gained his first engineering experience in the public works department at Ottawa, and since 1911 has been in private practice in Montreal. He is a member of several engineering societies in Canada, as well as abroad. He is a member of the Engineering Institute of Canada, the "Societe des Ingenieurs Civils de France," and the International Federation of Consulting Engineers, He was a member of the St. Lawrence River Commission, and is now a member of the Board of Directors of the Ecole Polytechinque, and of the Advisory Council for Scientific and Industrial Research. He has specialized in hydraulic and municipal engineering.

H. C. SWARTS, master mechanic of bridges of the Grand Trunk Railway, with headquarters in St. Thomas, has been appointed superintendent of bridges and buildings from Toronto to Portland, Maine, with headquarters in Montreal.

THOMAS S. SCOTT, professor in civil engineering at Queen's University, has resigned to undertake road construction work at Brockville. Prof. Scott has been at Queen's since 1915, with the exception of a year in Halifax with the Royal Canadian Engineers. He returned from Halifax last fall to take charge of the highway engineering course in the Science Faculty at Queen's, but this unfortunately failed to materialize.

NEW YORK STATE OPPOSES ST. LAWRENCE DEEP WATER ROUTE

STRONG opposition to the Great Lakes-St. Lawrence deep water route to the sea was presented by New York state interests at the session of the International Joint Commission, held in Buffalo recently. According to the testimony, New York City should continue to be the outlet for all the business of the United States and a great part of the business of Canada. Since New York state had expended an enormous sum in building a barge canal with a twelve-foot draft, the remainder of the country should use it for all time, though it meant two extra handlings, extra terminal charges and increased breakages.

Murray Hurlburt, commissioner of docks and ferries for New York City, stated that to carry through the St. Lawrence improvement would involve the abandonment of millions already expended in New York harbor. He admitted that there is congestion in handling the business now offering through New York, but added that it is not the fault of New York, but of the country as a whole. His remedy for insufficient transportation facilities was to wait.

Other witnesses adduced the arguments that the St. Lawrence development is impracticable, that ocean steamers cannot navigate canals, and that, anyway, there will never be enough business to justify the construction of the route.

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
Ancaster Tp., Ont., earthwork, rockwork and concrete structures	June 30.	June 10.	60
Burlington, Ont., construction of sanitary sewers	June 29.	June 17.	57
Cramahe Tp., Ont., earthwork, etc.	July 6.	June 17.	57
Edwardsburg Tp., Ont., macadam roadway	June 25.	June 3.	64
Edwardsburg Tp., Ont., macadam roadwork	July 2.	June 17.	62
Elizabethtown Tp., Ont., crushed stone	June 25.	June 10.	62
Hope and Hamilton Tps., Ont., excavation, concrete structures, etc.	July 2.	June 17.	66
Lancaster Tp., Ont., crushed stone	June 25.	June 10.	60
Milton, Ont., erection of school	June 26.	June 17.	60
Montreal, Que., work on C. N. R. Railway	July 3.	June 17.	64
Oakville, Ont., water works extensions	June 30.	June 17.	62
Pelee Tp., Ont., work on drainage system	June 26.	June 17.	56
Pickering Tp., Ont., macadam roadway	June 25.	June 3.	62
Regina, Sask., concrete bridges	July 6.	June 17.	64
Regina, Sask., concrete bridges	July 6.	June 17.	55
Saskatoon, Sask., erection of normal school	June 29.	June 17.	60
Simcoe County, Ont., construction of bridge	June 26.	June 17.	57
Thurlow Tp., Ont., earthwork, rockwork, macadam roadway, etc.	June 25.	June 3.	62
Toronto, Ont., plumbing and septic tanks	June 30.	June 17.	60
Toronto, Ont., laying and joisting of water pipes	June 29.	June 17.	56
Toronto, Ont., excavation, concrete structures, etc.	July 7.	June 17.	57
Toronto, Ont., special castings, cast-iron pipes, valves	June 29.	June 17.	58
Tyendinaga Tp., Ont., earthwork, etc.	July 6.	June 17.	57
Walkerton, Ont., gravel road	June 25.	June 17.	64
York Tp., Ont., concrete sidewalks, pavement and bridge.	June 26.	June 10.	53
York Tp., Ont., water mains	June 25.	June 10.	53

BRIDGES, ROADS AND STREETS

Amhertsburg, Ont.—F. W. Haas, chairman of the Amherstburg Board of Trade, and J. A. Auld, also of Amherstburg, waited on the Good Roads Committee of the Essex county council and received endorsation of the scheme to lay a paved highway from the township of Sandwich West to Amherstburg.

Barrie, Ont.—Simcoe County Council designated eight additional pieces of road as county provincial highways and added seven sections of road to the county roads system.

Belleville, Ont.—Hastings county council decided to expend $30,000 on the highway from Madoc to Tudor boundary, and for the highway from Madoc village to Addington boundary, an appropriation of $500 per mile was voted. On the highway from Belleville to Tudor $15,000 will be spent this year. Road superintendent, H. G. Bleecker, Box 77, Belleville.

Bifrost, Man.—Tenders will be received by I. Ingaldson, secretary-treasurer, up till noon, Monday, June 28th, 1920, for grading and clearing. Specifications may be secured from the secretary-treasurer, or from the Good Roads Board, Winnipeg.

Brampton, Ont.—County Council passed by-laws authorizing the taking over as good roads the Burnhampthorpe and Toronto Gore roads.

Brantford, Ont.—Oxford and Brant county councils are considering a proposal to make a provincial county road direct from Brantford to St. Thomas.

Brantford, Ont.—Brant county council's good roads program for this year calls for an expenditure of $160,000. Road Superintendent, A. M. Jackson, Brantford.

Chatham, Ont.—Plans and specifications are being prepared by the Suburban Road Commission for the paving of about 2¾ miles of the Raleigh and Harwich townline. Commission plans paving at a total cost of $170,000. Chairman, Russell Holmes.

Chatham, Ont.—Kent county council authorized W. G. McGeorge, Chatham, county engineer, to prepare plans and specifications for a bridge over the Thames River at Prairie Siding.

Chatham, Ont.—City council let contract to Western Construction Co. for concrete pavements on Seventh and Grant Streets.

Davidson, Sask.—Tenders will be received until June 30th, by Arthur Jas. Robertson, town clerk, for material and labor in constructing approximately 40,000 sq. ft. of concrete sidewalks and crossings. Specifications on application to town clerk.

Edmonton, Alta.—Tenders will be received by L. C. Charlesworth, Deputy Minister of Public Works, Edmonton, until 12 o'clock noon on Tuesday, July 6th, 1920, for grading, etc. (See official advertisement in this issue.)

Fertile Belt R.M., Sask.—Tenders, addressed to A. Wallace Shaw, secretary-treasurer, Bangor, Sask., will be received until 1 o'clock on June 28th, for all or parts of the undermentioned work, situated entirely in rural municipality No. 183, and consisting of approximately: 20,000 cubic yards grading, 14 miles turnpike, 10 miles regrading, 1,600 feet of pipe (placing and hauling). Plans and specifications may be seen at the office of the Parsons Engineering Co., Regina, and at the office of the secretary-treasurer.

Francis R.M., Sask.—The rural municipal council has awarded the contract for roadwork to A. E. Gerein, of Vibank, Sask. The councils of the rural municipalities of Leross and Punnichy, have awarded the contracts for roadwork to A. Gaundry, of Assiniboia, Sask. The total cost of the roadwork in these municipalities will be over $30,000. Parsons Engineering Co., of Regina, will supervise the work.

Grantham Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Highways, Toronto, until 12

o'clock noon, Wednesday, July 7th, 1920, for the excavation, construction of concrete structures, etc., on the Provincial Highway in Grantham, Niagara, Clinton, Saltfleet and North Grimsby townships. (See official advertisement in this issue.)

Hamilton, Ont.—Dominion government voted $334,100 for roads and bridges, of which $100,000 is for a new bridge over the Burlington Channel, Hamilton Beach.

Hazelwood, Sask.—Rural municipal council has awarded the contract for 135 miles of roadwork. C. L. Cameron, the municipal engineer, will supervise the work.

Montreal, Que.—Reports for paving St. Patrick St., Connaught and Hampton Avenues, at an estimated cost of $86,000 were adopted by the city council. A. E. Doucet, director of public works.

Nepean Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Highways, Parliament Buildings, Toronto, up to 12 o'clock noon, Wednesday, July 14th, 1920, for earthwork, etc. (See official advertisement in this issue.)

North Bay, Ont.—Public works committee recommend acceptance of A. Gartshore's tender at $4,875.81 for construction of sidewalks.

Pemberton Meadows, B.C.—A timber bridge will be constructed over Ryan Creek. Engineer Todd will superintend operations. A main roadway is being surveyed.

Quebec, Que.—Tenders will be received until one o'clock p.m., July 10th, 1920, at the office of B. Michaud, Deputy Minister of Highways, Parliament Buildings, for the construction of gravelling on the "chemin de front du Bord de l'Eau" (about seven miles).

Saanich, B.C.—A recommendation that the Hagan bridge be rebuilt was received from the municipal engineer by the works committee of the Saanich council. Clerk, H. S. Cowper.

Sarnia, Ont.—The question of enlarging the paving system of the south ward is being considered by the city council. City engineer, J. A. Baird.

Spy Hill R.M., Sask.—The rural municipality has awarded the contract for road work to C. Paulson, of Gerald, Sask., and W. W. Allen, of Spy Hill. The work will be under the direction of the Parsons Engineering Co., Regina.

St. John, N.B.—City council will construct a concrete sidewalk on Millidgeville Rd. at a cost of $2,400. City engineer, G. N. Hatfield.

St. Lambert, Que.—The following tenders were received by the town council for paving: Petit Bois Rd., Hy. L. St. George, $10,013; J. F. R. Leduc, $13,344. Tiffin Rd., Hy. L. St. George, $25,003; J. F. R. Leduc, $32,556. Town Engineer Drinkwater's estimates are $8,182 and $20,156, respectively. Council decided to send these to the provincial roads department, Quebec, for approval.

St. Lambert, Que.—In connection with road improvements along the South Shore of the province, tenders will be called for paving Cote Noir Rd. for a distance of 2½ miles; the present thoroughfare between St. Lambert and Longueuil is to be repaired; a sidewalk is to be laid along the King Edward Highway, from St. Lambert to the Country Club; the Tiffin Rd. will be paved from the River Rd. to the Petit Bois Rd. with bituminous macadam; the Petit Bois Rd. will be paved between the Tiffin Rd. and the Cote Noir Rd., and St. Louis Ave., from the junction of Petit Bois Rd. to Victoria Ave. will be paved. Address: E. Drinkwater, Town Engineer, St. Lambert.

St. Patrice de Sherrington, Que.—Contract let by town council to Dore Archambault, Ste. Martine, Que., for macadamizing roads. Estimated cost, $30,000.

Swan River, Man.—Tenders will be received by Jos. Armstrong, secretary-treasurer, up to 12 o'clock noon, Tuesday, July 6th, 1920, for the construction of a reinforced concrete bridge over Thunder Hill Creek. Specifications may be obtained at the office of the highway commissioner, Winnipeg, or at the office of the secretary-treasurer.

Toronto, Ont.—Contracts awarded as follows by board of control for pavements: Asphalt pavement—To the Godson Contracting Co., Dickens Ave., from Logan Ave. to Carlaw Ave., $9,862; Gerrard St., from Main St. to the eastern city limits. To Commissioner of Works R. C. Harris, Gilmour Ave., from Dundas St. to Maria St., $3,988; Indian Grove, from Howard Park Ave. to 234 ft. north, $3,259; Montclair Ave., $2,188. Bitulithic pavement—To the commissioner of works, Gilmour Ave., from Woodside Ave. to Annette St., $10,705; Rose Park Drive, from Ingelwood Drive to Welland Ave., $36,876; Roxton Rd., $21,183; Peddington Park Crescent, $1,936.

Toronto, Ont.—Tenders will be received up to noon, Tuesday, June 29th, 1920, for the construction of asphalt pavements, asphalt surface, bitulithic pavement, concrete curbings and concrete sidewalk. Tenders must be addressed to T. L. Church (Mayor), chairman, board of control, City Hall, Toronto. Specifications may be obtained at the Department of Works, City Hall.

Toronto, Ont.—City council approved the opening of a 33-ft. street on the eastern city boundary, running north from the waterfront.

Tres St. Sacrament, Que.—Tenders addressed to D. R. Hay, Secretary, Howick, Que., will be received by the municipal council of the parish of Tres St. Sacrament up to 1 o'clock p.m., Monday, July 5th, 1920, for the painting of the following bridges: Allen's Corners, Turcot and Pont Flottant. Specifications may be seen at the office of this Corporation.

Tres St. Sacrament, Que.—Tenders addressed to D. R. Hay, Secretary-treasurer, Howick, Que., will be received by the municipal council of the parish of Tres St. Sacrament up to 1 o'clock p.m., Monday, July 5th, 1920, for the construction of a 20-ft. span of a reinforced concrete bridge and approaches over the Adam's Creek. Plan and specification may be seen at the office of this Corporation.

Vancouver, B.C.—The city council awarded the contract for hard-surfacing city streets this year to the Columbia Bitulithic Co. for $1.25 a yard for bitulithic and $1.20 a yard for asphalt paving. It is estimated that some 44,000 yards will be required, bringing the amount of the contract to about $55,000.

Vancouver, B.C.—The city council has referred to the city engineer for tabulation tenders from W. Greenlees and Boyd & Jackson for the widening of Connaught bridge. The tenders were each for about $11,000.

Wingham, Ont.—On July 5th by-law authorizing borrowing of $18,500 for construction of bridge will be submitted. Clerk, John F. Groves.

Welland Ont.—City council let contract for sidewalks to Somerville and Dilworth.

Woodstock, Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until 12 o'clock noon on Wednesday, July 14th, 1920, for excavation, construction of concrete structures, etc., on the Provincial Highway, between Woodstock and London. (See official advertisement in this issue.)

Woodworth, Man.—Tenders will be received by W. V. Stevenson, secretary-treasurer, up to 12 o'clock noon, June 30th, for reinforced concrete culverts.

WATER, SEWAGE AND REFUSE

Brandon, Man.—Recommendations regarding the electrification of the water works system were made to the city council by G. L. Guy, a member of the utilities commission, and W. M. Scott, consulting engineer. Estimated cost, $35,000. A sedimentation basin was also suggested. This would cost in the neighborhood of $40,000.

Buckingham, Que.—Town council plans improvements to water works system costing $75,000. Secretary-treasurer, David Ray.

Chilliwack, B.C.—Elk Creek Water Co. will construct a new cast-iron water main at a cost of $9,000.

East Kildonan, Man.—Council plans construction of a sewer and water main on Cawdor St., from Trent Ave.,, for a distance of 410 ft. north; sewer in District No. 1 and water main in Leighton Ave. Clerk, H. Thompson, Box 15, East Kildonan.

Kitchener, Ont.—The water works department will in all probability proceed with the development of the proposed Bridgeport water supply scheme this year, the work to be completed in 1922. City engineer, B. G. Michel.

London, Ont.—It is expected that a vote will be taken in January on a scheme to augment the city water supply.

North Bay, Ont.—Fire, water and light committee recommended that tenders be called for extension of water mains on Wylde St. and Third Ave. Also that an estimate be obtained for installing a water meter system. Town engineer, H. J. McAuslan.

South Vancouver, B.C.—Plans are being prepared by Municipal Engineer Whittaker for the construction of a community septic tank in the vicinity of St. Catharines St. and Fifty-first Ave. It is planned at some future date to construct a sewer from Fifty-first Ave. to the Fraser River on Inverness St. at a cost of from $125,000 to $150,000.

St. John, N.B.—Board of School Trustees considering erection of two new schools. Chairman, Dr. A. E. Emery.

Stratford, Ont.—Board of works recommended that sewers be constructed on Nelson St., from Gore to Cambria St., and on Chestnut St., from Cedar St. to Railway Ave. City engineer, A. B. Manson.

Toronto, Ont.—Civic works committee authorized the construction of a new sewer on York St., south of King St., at an estimated cost of $29,668.

Welland, Ont.—City council let contract to Somerville and Dilworth for sewer on Seeley St.

Wiarton, Ont.—Town council decided to recommend to the Water Commissioners the installation of a two-inch water main on Frank St. East. Clerk, J. H. Fielding.

Windsor, Ont.—City council passed by-law authorizing the raising of $150,000 for water works extensions, and installation of mains and booster pumps for additional fire protection. City engineer, M. E. Brian.

Wingham, Ont.—By-law will be submitted on July 5th to authorize raising $6,500 for water mains on north side of Maitland River. Clerk, John F. Groves.

Winnipeg, Man.—Tenders addressed to the chairman, Committee on Fire, Water, Light and Power, will be received at the office of C. J. Brown, city clerk, up to 3 o'clock p.m. on Monday, June 28th, 1920, for the supply and delivery, f.o.b. Lac du Bonnet, Man., freight and duty paid, of a quantity of gate valves and accessories for the 1920 extension to power-house, Point du Bois. Specifications may be obtained at the office of the City Light and Power Department, 54 King St.

Winnipeg, Man.—Tenders addressed to the chairman, Committee on Fire, Water, Light and Power, will be received at the office of C. J. Brown, city clerk, up to 3 o'clock p.m. on Monday, June 28th, 1920, for laying the water mains in Queenston and Magnolia Sts. Specifications may be obtained at the office of the City Engineer, 223 James Ave.

LIGHT, HEAT AND POWER

Ottawa, Ont.—Tenders will be received by the chairman of the Ottawa Hydro-Electric Commission on High and Low Tension Cables, up till 12 o'clock noon, July 2nd, 1920. Specifications may be seen at the construction office, 75 Laurier Ave. West, Ottawa. Tenders to be addressed to the chairman of the commission.

Pembroke, Ont.—Waterworks committee of town council received the following tenders for auxiliary gasoline units: Fraser and Chalmers, of Canada, Ltd., 1 1,200 Imp. gal. gasoline unit, $15,500; 1 800, $12,000; 2 800, $23,000. Pyke Motor and Yacht Co., Ltd., 1 1,200 Imp. gal. unit, $15,780; 1 800, $13,297; 2 800, $26,194. E. J. Phillips and Sons, Ltd., 1 1,200 Imp. gal. unit, $14,909; 1 800, $11,512; 2 800, $20,974. Turbine Equipment Co., Ltd., Toronto, 1 1,200 Imp. gal. unit, $12,800; 1 800, $9,500; 2 800, $18,250. On the advice of Willis Chipman, consulting engineer, Toronto, contract was let to the Turbine Equipment Co., Ltd., for two 800-gal units. The estimated cost of installation with alterations to buildings, etc., is $23,000.

Toronto, Ont.—Tenders will be received addressed to T. L. Church (mayor), chairman board of control, City Hall, Toronto, up to 12 o'clock noon, Tuesday, June 29th, 1920, for the following: Tender No. 48—Lathe, for main pumping station. Specifications may be obtained at the works department, Room 12, City Hall.

Vancouver, B.C.—Civic Board of Works opened the following tenders for the hard-surfacing of several miles of streets: Columbia Bitulithic, Ltd., $1.20 per sq. yd. and the Cotton Co., Ltd., $1.22 per sq. yd. Both tenders were referred to the City Engineer for report to the city council. The amount of paving involved amounts to about $85,000.

Virden, Man.—Tenders will be received at the office of J. M. Leamy, Power Commissioner, Winnipeg, up to 12 o'clock noon of Wednesday, July 7th, 1920, for the supply of a power house building, to be erected at Virden, Man., for the Manitoba Power Commission. (See official advertisement in this issue.)

Winnipeg, Man.—Ratepayers defeated the Maryland bridge by-law.

Winnipeg, Man.—Tenders will be received at the office of J. M. Leamy, Power Commissioner, Winnipeg, up to 12 o'clock noon of Wednesday, July 7th, 1920, for the supply of two 3-phase, 2,300-volt generators and switching equipment required by the Manitoba Power Commission. (See official advertisement in this issue.)

Winnipeg, Man.—Tenders will be received at the office of J. M. Leamy, Power Commissioner, Winnipeg, up to 12 o'clock noon of Wednesday, July 7th, 1920, for the supply of two semi-Diesel engines for direct connection to A.C. generator required by the Manitoba Power Commission. (See official advertisement in this issue.)

Winnipeg, Man.—Tenders addressed to the chairman, Committee on Fire, Water, Light and Power, will be received at the office of C. J. Brown, city clerk, up to 3 o'clock p.m. on Monday, June 28th, 1920, for supply and delivery, f.o.b. Winnipeg, of 5,000 (more or less) suspension type insulator units, freight and duty paid. Specifications may be obtained at the office of the City Light and Power Department, 54 King St.

RAILWAYS

Calgary, Alta.—A total expenditure of $172,646.45 will be made on the street railway this year, according to Supt. R. A. Brown.

Chatham, Ont.—The Gray-Dort Motors, Ltd., have been given permission by the city council to construct two spurs to their plants.

Montreal, Que.—Plans for the proposed street car line up Mount Royal have been submitted to the Administrative Commission. A. E. Doucet, Director of Public Works.

St. John, N.B.—Dominion government is being urged to authorize the construction by the C.N.R. of the 22-mile connecting link between the St. John and Quebec Railway at Meductic to the Maine Central at Bancroft, Maine.

Toronto, Ont.—Premier Drury announced that the reconstruction of the Timiskaming and Northern Ontario Railway is under active consideration.