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SAULT STE. MARIE WATER SUPPLY PROJECT

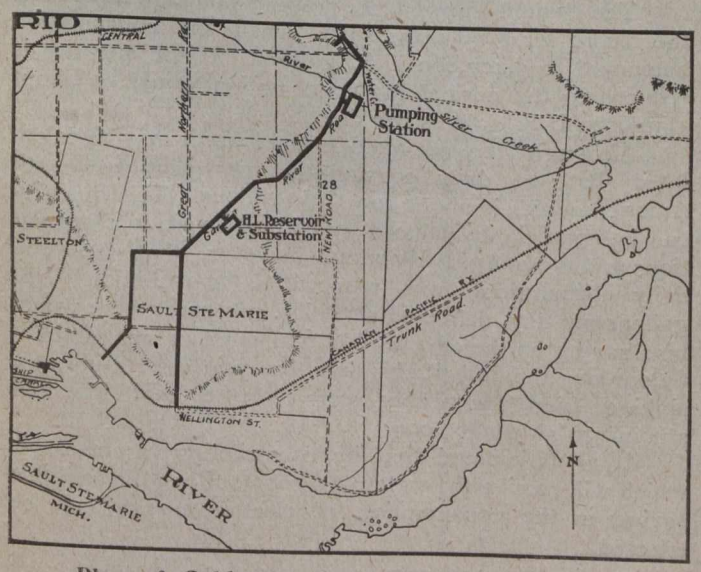
Present Source Badly Polluted and Filters Must Be Installed or New Supply Obtained—Investigation of Five Possible Schemes Favors Gravity Supply From Coldwater Creek—Brief Abstract of Some Portions of Report Just Made to the Sault Ste. Marie Water Commissioners by

R. O. WYNNE-ROBERTS, M.Can.Soc.C.E., F.R.San.Inst.
Consulting Engineer, Toronto

WATER was first supplied in 1887 by the Sault Ste. Marie Water, Gas and Light Co., and after vicissitudes the works were taken over by the town in 1890. In 1895 they were disposed of to the Tagona Water, Light and Power Company, and in 1914 the city re-acquired the waterworks system.

The present pumping station forms a part of the Great Lakes Power Company's hydro-electric power house, and as large extensions are now being made thereto it was necessary to dismantle and remove the water-driven Northey horizontal duplex pump. In its place has been installed at the other end of the power house and near the steam fire pumps, an electric-driven centrifugal pump having a water capacity of about three million U.S. gallons per day.

There are also three steam-driven horizontal duplex fire pumps, one having a capacity of about 1,200,000 U.S. gallons per day and two each of about 1,320,000 U.S. gallons daily. The normal station water pressure is about 80 gallons per square inch, and a fire pressure of 110 lbs. per square inch. The pressure at the Queen Street fire hall is about 70 and 100 lbs. respectively. The Lake

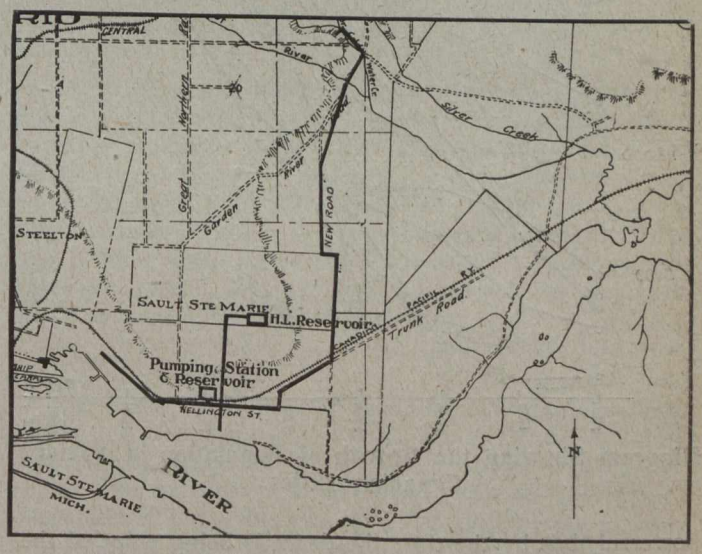


Plan of Coldwater Creek Pumping Scheme.

Superior Pulp Co. supplies steam at about 80 lbs. pressure through pipe from an adjoining building.

Owing to the extensive alterations it has been necessary to rearrange the suction and delivery mains at the pump station. The intakes were formerly at Nos. 1 and 2 penstocks with an emergency connection to the ship canal by means of a wooden pipe connected to a 5-ft. branch of a 7-ft. steel pipe fed from above the upper lock.

These have been removed and water is now taken from Penstocks Nos. 4 and 6 and from the tail race. A



Plan of Coldwater Creek Gravity Scheme.

new 16-inch steel main will be laid to re-establish the connection with the ship canal.

The water taken from the power and ship canals, as shown by several investigations, is unsatisfactory in quality. It is inevitable under the circumstances which obtain in the neighborhood that undesirable matter and liquid from shipping, works, operations and surroundings, will continue to be discharged into the canals. Moreover, the power canal is being much enlarged, and the connection to the river above the C.P.R. bridge has to be dredged, when mud, debris and filth will be scoured by the current, and carried towards the intakes, and in this manner render the water unfit for use. During the dredging operations water will be taken from the ship canal, but as ships move to the bollards near the upper lock and discharge refuse close to the intake it will be seen that the quality will be polluted during the navigation season.

Having regard to the present situation, there can be no doubt that whilst the arrangements may be as good as can be made under the existing circumstances, the supply of water is unsatisfactory in quality, somewhat precarious to obtain and expensive to operate. The only

precaution which can be applied is a rigorous supervision of the process of sterilization which has been carried on since 1913 by the generous use of hypochlorite of lime. In this connection it may be explained that the quantity of water pumped is measured by means of a pitot tube which indicates the fluctuating quantity from time to time. The water is examined by the chemist of the Lake Superior Pulp Co. and hypochlorite of lime is added according to his direction. It is desirable to observe, however, that this lime is delivered in large iron drums, and once they are opened the lime deteriorates rapidly. It is therefore essential that it should be tested frequently to ascertain the available chlorine contained therein, for even if the correct quantities are used as per the chemist's direction, the proportion of chlorine content is gradually diminishing. Unless attention is paid to this the chlorination will vary. When a new drum is opened the chlorine will be

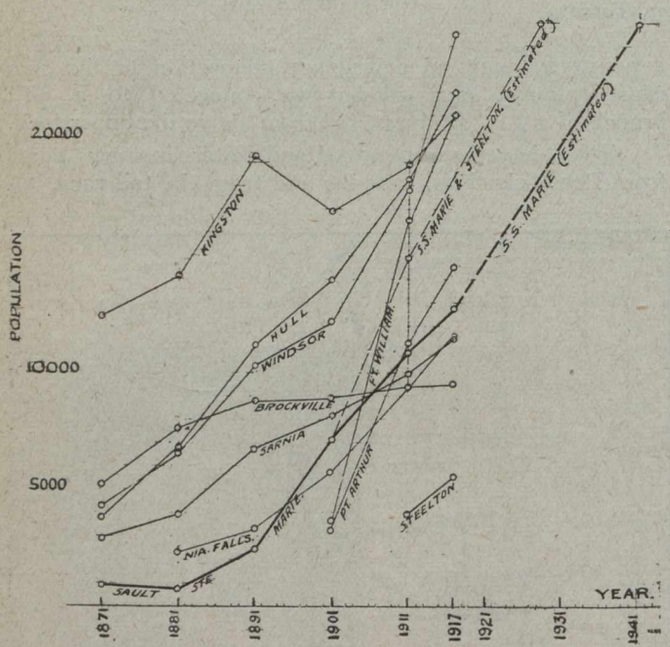


Diagram Showing the Growth of Population in Various Canadian Cities.

powerful, but by the time the drum is being emptied the chlorine will be inadequate.

Apart from reasons of quality and reliability of supply the city is under an obligation to provide a pump station and to remove the pumps out of the present building. The company is entitled to call upon the city to comply with the agreement by giving six months' notice.

The water is delivered to the city through two mains, a 24-inch and a 10-inch, and is measured by means of a pitot tube inserted in the 24-inch main in the pumping station. This is connected to a glass U-tube. As the velocity of the flow of water in the mains fluctuates according to the changes in the rate of consumption, the hydraulic head correspondingly varies and causes the liquid in the U-tube to rise and fall. This gauge (supplied by the Municipal Supply Co., Chicago, in 1915) is calibrated to indicate the quantity of water pumped. The attendant makes periodical observations and records them and computes the approximate pumpage. These computations, added up, give the daily supply.

According to the records the average daily quantity pumped during the year ended September 30th, 1915, was about 2,084,000 U.S. gallons. The largest quantity during one day was about 2,726,000 U.S. gallons. The average consumption per head per day was about 150 U.S. gallons. During the six months ending 31st March, 1915, the maximum daily pumpage was the same as above; the average daily pumpage was about 2,257,000 U.S. gallons, and the daily average per head was about 174 U.S. gallons. These figures were extracted from the fire underwriters' report dated 9th October, 1915, but converted into U.S. gallons.

The report sheets of the pump attendant for twelve months ending June 13th, 1917, show that the daily consumption ranged from 2,557,000 U.S. gallons on November 18th, 1916, to 3,823,000 U.S. gallons on April 6th, 1917. The average daily consumption during the past year was approximately 3,200,000 U.S. gallons. The average from the 1st to the 13th June was 3,400,000 U.S. gallons daily.

There is no apparent reason why such a large quantity of water should be necessary for Sault Ste. Marie.

The hourly fluctuations are exceedingly small. Following is a table based upon the assumption that there are no great industrial users of water who require large quantities during the night time:—

Table I.—Showing the Present and Normal Requirements.

Hour morning	Present pumpage gallons per minute	Normal pumpage gallons per minute	Hour evening	Present pumpage gallons per minute	Normal pumpage gallons per minute
1	2,180	837	1	2,540	1,314
2	2,180	792	2	2,570	1,242
3	2,190	720	3	2,580	1,188
4	2,200	711	4	2,540	1,125
5	2,140	711	5	2,520	1,062
6	2,200	729	6	2,480	1,044
7	2,250	891	7	2,460	1,062
8	2,340	1,125	8	2,430	1,062
9	2,420	1,287	9	2,350	1,062
10	2,480	1,404	10	2,280	1,017
11	2,560	1,404	11	2,210	963
12 (noon)	2,580	1,350	12 (midnight)	2,170	945

The column showing the present pumpage represents the record for May 14th, 1917, when the consumption amounted to 3,407,000 U.S. gallons. If the quantity is reduced to the normal the consumption would be about 1,500,000 U.S. gallons per day.

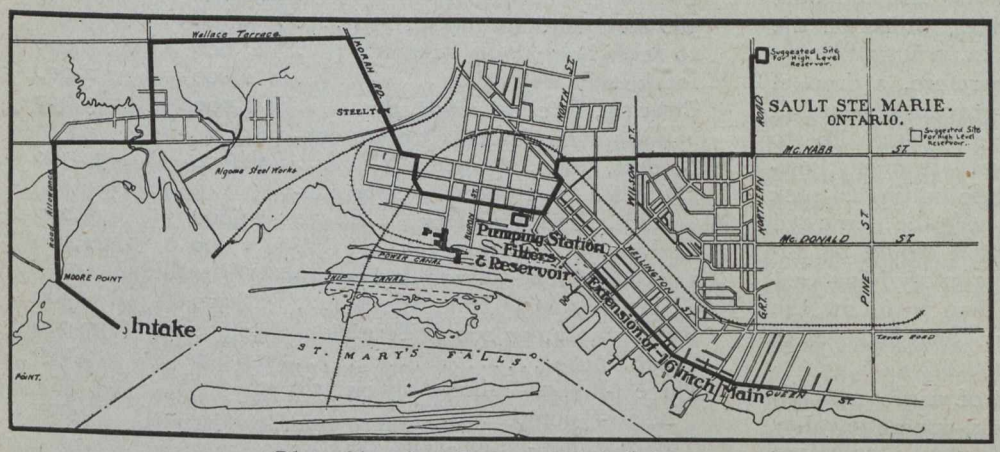
Although there are many exceptions, it may be calculated that the daily consumption per head in North American cities is about 100 U.S. gallons. This quantity can be appreciably reduced by careful inspection, regulations and metering. Allowing, however, that the total daily consumption was reduced to two million U.S. gallons per day, delivered at 80 lbs. pressure, there would be a saving on the cost of electrical energy alone of about $2,000 per annum. If this sum was yearly set aside as a sinking fund for twenty years at 5 per cent. it would amount to about $66,000.

It is anticipated that by constructing a reservoir which will receive the water at a constant head, a tangible saving in the consumption of electric energy can be effected.

Requirements with Respect to Supply of Water.

It is reasonable to estimate that the population of Sault Ste. Marie will increase to at least 20,000 by 1931, and if Steelton unites in the meantime, the total population will probably be at least 27,300 by 1931. It is possible, however, that the increment will exceed this estimate; indeed, it is urged that the future industrial ex-

pansion will warrant the expectation of a total of 30,000 persons within a few years and that provision should be made to meet it. It is certain that electro-chemical and electro-metallurgic processes will be exploited as the scientists make new discoveries, and commercialize them. It is a fundamental principle of city planning to devise



Plan Showing Moore Point Scheme.

schemes which will be ample and satisfactory for the future. But it will be essential to construct only so much as may be necessary from time to time to safely satisfy the current requirements.

The Canadian Fire Underwriters' Association stipulate that the standard supplies for cities should be as follows:—

Table 2.—Showing the Requirements of the Underwriters.

Population	Standard fire streams U.S. Gallons	Normal supplies U.S. Gallons	Single style pumping capacity U.S. Gallons	Reservoir capacity U.S. Gallons
15,000	3,600,000	1,800,000	5,400,000	5,400,000
20,000	4,320,000	2,400,000	6,720,000	6,720,000
30,000	5,040,000	3,600,000	8,640,000	8,640,000
40,000	5,760,000	4,800,000	10,560,000	10,560,000

As a supply of water entirely by gravitation is not available for Sault Ste. Marie, pumping must be resorted to. Water may be pumped from the source to a high-level reservoir, or it may be delivered by gravity to a reservoir in the city and afterwards pumped into the mains and the surplus discharged into a high-level reservoir.

It will be observed that a total population of 30,000 will require a normal supply of 3,600,000 U.S. gallons daily and a combined normal and fire supply at the rate of 8,640,000 U.S. gallons daily. It is evident that it would not be economical to pump long distances for fire extinction, therefore it will be necessary to build a reservoir to store sufficient water for this purpose.

In this connection it is desirable to point out that the capacity necessary to combat fires will involve about 60 per cent. of the pumping plant of the new schemes. During 1916 there were about 57 alarms which necessitated working the steam fire pumps for an aggregate of about 54 hours.

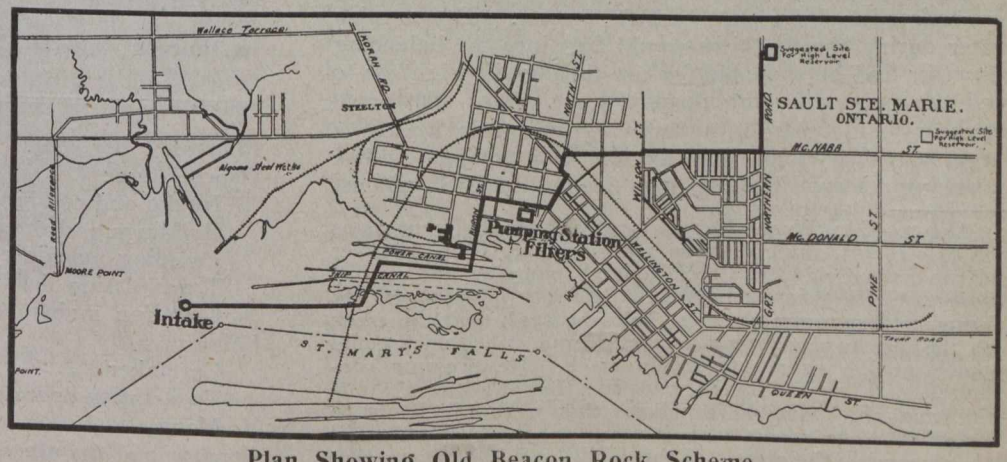
Gros Cap the Ultimate Scheme.

The ideal site for an abundant supply of good water is that at Gros Cap. The results obtained by the International Joint Commission point to this fact. Shallow water extends from the shore for most of the distance up St. Mary's River and around Point aux Chenes, but at Gros Cap the water is deep close to the beach. The intake, however, would have to be extended into the lake for a short distance to avoid the pollution which hugs the shore. Intake and main construction at this point would not be subject to disturbances due to dredging, building canals or other works which are inherent possibilities in connection with intakes located on St. Mary's River.

High winds will doubtless cause the drifting inshore of flocculent organic matter from the lake, but in all probability this would not be sufficient to warrant the need for filters. A slight measure of chlorination, when necessary, would provide the required safeguard.

The principal disadvantage of drawing water at present at Gros Cap is the capital expenditure which would be involved in the construction of the trunk main. This main, laid to a reservoir, say, in Andrew Street, would be about 13½ miles long, and to Pine Street reservoir it would be about 15 miles in length. The frictional loss of head when delivering 6,000,000 U.S. gallons daily through a main, say, 15 miles long would be about 132 ft. of 27-inch. To these figures must be added about 30 ft. to overcome the ridge which parallels the lake from Gros Cap southward.

It would be financially impracticable to undertake a scheme of drawing water at Gros Cap at the present time, and it must, therefore, be set aside. In view of the fact that St. Mary's River schemes are liable to interference, especially if the industrial progress of the city is great and the shipping continues to expand, Gros Cap will



Plan Showing Old Beacon Rock Scheme.

doubtless be the place where the ultimate water scheme will be located. Meantime, it is desirable to bear in mind how the water from that source can be supplied to and from a part of any present schemes, without causing a serious dislocation of the works or abandonment of any part. This has been kept in view so far as possible in con-

nection with all plans* described in this report, and in the recommendations which will be made, it will be seen that Gros Cap works would fit in and constitute a part of the ultimate entire program of works.

Coldwater Creek Gravity Scheme.

The elevation at the confluence of the east and west branches of this creek is about 673 feet, whilst on the Trunk Road where the new road will join, it has an elevation of about 638 feet. There is, therefore, a drop of about 35 feet, which is ample for a gravitation conduit and thus eliminate the necessity for transmission line to and installing pumps near Root River. It must, however, be pointed out that to avoid a deep cutting in rock for a short distance along the road where the new road connects with the Garden River Road it would be advisable to lay the conduit through the property lying east of it. This would be less expensive than to follow the highway, as, no doubt, the right-of-way could be acquired at small cost.

The conduit would be constructed of reinforced concrete and laid from the intake at the fork, down the valley of Coldwater Creek, then along the highway to Root River Bridge. From this point the conduit would make a small detour to avoid the rock-cutting already mentioned and join the new road, a short distance south of Garden River Road. It would then be laid on the side of the new road, along the Trunk Road, as far as Pine Street, and there be connected to a reservoir. The total length of the conduit would be approximately 6 miles.

Since the cost of a reinforced concrete conduit for a daily supply of, say, six million U.S. gallons of water per day is not very much less than that for ten million U.S. gallons, it is advisable to estimate for the latter size. By adopting this idea, the city would have at its command practically ten million U.S. gallons daily, although by regulating the valves at the intake the supply to the Pine Street reservoir would only be sufficient to keep the storage at full capacity, and to be constantly overflowing.

The pumping plant and reservoir would be at any convenient place having an elevation of about 610 feet. For the present purposes a site near Pine Street is suggested. The water would be pumped into the city mains through two mains with a connection to a balancing reservoir near Pine and McNab Streets. The surplus water during the day time would flow into the balancing reservoir and be available for use during the night or to feed the pumps for fire purposes. It is not considered necessary to construct a receiving reservoir having a larger capacity than two million U.S. gallons and a balancing reservoir holding, say, five million U.S. gallons. The pumps would be in duplicate, one set operated by electric motors and the other set by steam or Diesel engines.

*NOTE.—Mr. Wynne-Roberts presents five different plans with this report, three of them taking supply from the river and two from Coldwater Creek (one by pumping and one by gravity). He recommends the Coldwater Creek gravity scheme, and suggests that test holes be sunk near the creek with the idea of developing a supply from wells which could supplement the supply from the creek. He presents considerable data regarding the geological formation of the district, from which data he concludes that wells will likely be successful. The report also includes much bacteriological data concerning the river and the creek, and it is shown that the river is very polluted while the creek shows much better quality, and the watershed of the creek can be fenced in and protected without exorbitant cost. Aside from the pollution of the river, says Mr. Wynne-Roberts, it is not desirable to build an intake into the river on account of the building and dock operations which will be carried out along the river front in the future, and which would disturb the intake and perhaps necessitate its being moved from place to place as the need of shipping or industry might dictate.—EDITOR.

Estimated Cost of Coldwater Creek Gravity Scheme.

	Ultimate for 30,000 pop.	Present for 20,000 pop.
300 acres land around springs	$ 9,900	$ 9,900
20 acres land along stream	600	600
Intake and well	2,000	2,000
Clearing, fencing, roads, etc.	5,000	5,000
2¾ miles reinforced concrete conduit, 30-in. diameter	72,500	72,500
3¼ miles reinforced concrete conduit, 27-in. diameter	73,000	73,000
Cottage for caretaker	1,000	1,000
1 acre land for reservoir and pumping station in Pine Street	500	500
Reservoir, 2,000,000 U.S. gallons	30,000	30,000
Pump house	12,000	10,000
Three 4-million-gallon-daily electric driven pumps	20,000	20,000
Two 1-million-gallon-daily electric-driven pump	5,000	2,500
Three 4-million-gallon-daily steam-driven pumps	30,000	.....
Pipe connection in pump house	8,000	6,000
Two cottages	2,000	1,000
Transmission line	8,000	6,000
Switchboard, crane, meter, etc.	5,000	5,000
24-inch main to balancing reservoir, 7,000 ft.	77,000	77,000
12-inch main to high-level district, 6,000 ft.	25,000	20,000
24-inch main to Bruce St., 7,609 ft.	91,200	91,200
12-inch main to Queen and Pine Sts., 2,000 ft.	9,000	9,000
Land for balancing reserv'r, 2 acres	1,000	1,000
Balancing reservoir, 5,000,000 U.S. gal.	75,000	40,000
Miscellaneous	10,000	6,000
	$571,700	$489,200
Contingencies	57,170	48,920
Totals	$628,870	$538,120

Estimated Annual Cost of Coldwater Creek Gravity Scheme.

	For 30,000 pop.	For 20,000 pop.
Interest, 6 per cent.	$37,723	$32,287
Depreciation:		
Intake and conduit, 2%	2,940	2,940
Buildings and reservoir, 2%	2,460	1,620
Pumping machinery, 5%	2,750	1,125
Transmission lines 5%	650	550
Cast-iron mains, 2%	4,204	4,204
Labor:		
Caretaker	800	800
Two station operators	3,000	3,000
Men	1,000	500
Repairs and maintenance	500	300
Supplies	300	200
Power:		
Electric	10,340	7,260
Steam	1,800	....
Miscellaneous	1,000	750
Totals	$69,476	$55,536

Summary of Estimated Expenditure.

Capital Expenditure	for 30,000 pop.	for 20,000 pop.
Moore Point Scheme, No. 1	$754,160	$599,060
Moore Point Scheme, No. 2	728,970	570,790
Old Beacon Rock Scheme	757,680	588,830
Coldwater Creek Scheme No. 1.	802,758	582,274
Coldwater Creek Scheme No. 2.	628,870	538,120
Annual Cost—		
Moore Point Scheme No. 1	84,352	64,916
Moore Point Scheme No. 2	86,660	66,889
Old Beacon Rock Scheme	84,896	66,696
Coldwater Creek Scheme No. 1.	84,593	62,375
Coldwater Creek Scheme No. 2.	69,476	55,536

Availability, Permanence and Quality of Supply.

St. Mary's River is capable of affording an inexhaustible supply of water for all time. Unfortunately, it is polluted, but by efficient filtration the water can be made satisfactory and safe for public use. The intakes, however, are perforce to be in close proximity to the ship channel or in the part which may be used by vessels. The intake main has either to cross the water-front property of the Lake Superior Power Co. or over government property. The repairs and maintenance of submerged pipes and works would be difficult and expensive. Owing to the future expansion of the shipping, power and industrial enterprises it is doubtful whether an assured permanence of the intake works is possible.

Coldwater Creek is able to furnish all the water needed by Sault Ste. Marie for a long period. The water is excellent in quality and rendered pellucid by natural filtration. Repairs and maintenance can be easily carried out as all the works would be conveniently accessible either on the city's property or on public highways. The works would not be liable to disturbance, except perhaps to an insignificant extent due to the expansion of the city eastwards, when the concrete gravity conduit may have then to be replaced by cast-iron pipes to prevent any chance of the water being contaminated by crossing sewers.

Not Much Difference in Cost.

The difference in the cost of the St. Mary's River schemes is small. The Coldwater Creek Scheme No. 1 would cost approximately the same as the St. Mary's River Schemes, but there are no difficulties to overcome and the prices allowed are, therefore, possibly high. The Coldwater Creek Scheme No. 2 would cost less, both initially and annually, than any of the other schemes.

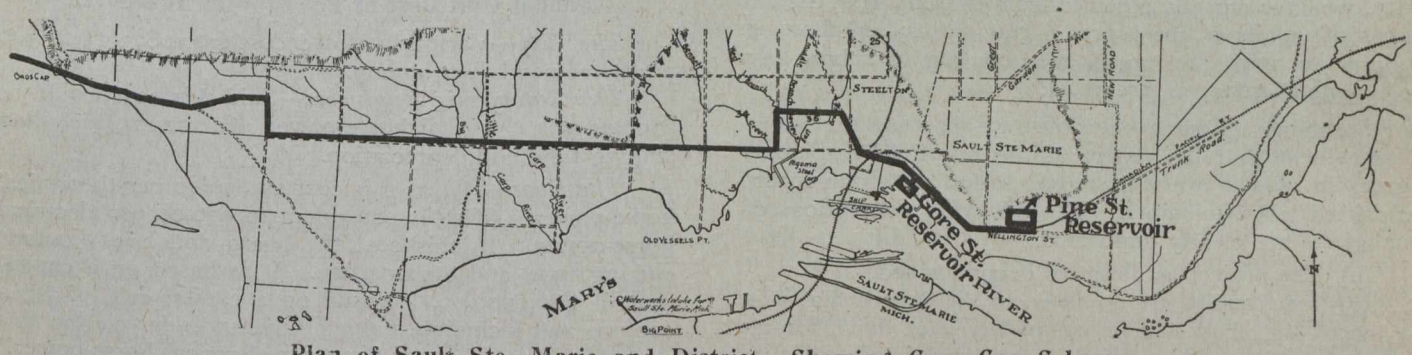
It is evident that Coldwater Creek Scheme No. 2 will be the most satisfactory, both from the sanitary and financial point of view. As the burden of having a reserve steam plant would be adequately compensated by increased reliability in case of fires, such a plant, or its equivalent in other forms of acceptable power, should be installed.

Temporary Measures.

Having regard to the terms of tenancy of the present pumping station, the following are suggestions as to temporary measures which may be permitted:—

Provided the sewage and tradewastes are intercepted and discharged sufficiently downstream, water could no doubt be abstracted from the tailrace near Huron Street. It could be conveyed by means of 24-inch diameter wood-stave pipes to a well adjoining the substation. This would mean a main about 2,300 feet in length, laid in a trench about 10 feet deep in a low-lying district. The pumps would be electric driven and placed either at the Gore Street substation or in an adjoining building. The water would be chlorinated and be pumped into the existing city mains.

The provincial sanitary engineer (F. A. Dallyn, B.A.Sc.) is prepared to approve of these measures, which must be considered as entirely temporary. The cost would probably range from $60,000 to $100,000, according to circumstances, but the machinery would be transferred to the new station when it was ready.



Plan of Sault Ste. Marie and District, Showing Gros Cap Scheme.

Control of Consumption of Water.

At the present time the water is measured by a pitot tube which, no doubt, has been calibrated, but owing to the small apertures it is liable to interference. Moreover, even if the operators are conscientiously careful in their records it will be more reliable if the records are made automatically, as would be the case with a Venturi meter. This meter would be available to control a chlorinator which employed chlorine of a constant quality, but its particular object would be to obtain a continuous record of the consumption during every moment of the 24 hours. With such an instrument the officials could periodically shut off various districts at night and observe the reduction in flow and thus localize the leaks.

This would enable inspectors to rapidly eliminate grievous waste, and later on to eradicate others, less pronounced, yet in the aggregate cause a serious burden on the waterworks plant. As this work would proceed, the night line on the charts would assume the characteristic curves to be found where the consumption is reasonable. Where services are exposed to risks of freezing, the plumbing should be rearranged and if thought advisable the work might be done by the city and assessed against the properties. Plumbing regulations should be formulated and enforced, prescribing the strength, quality and location of fittings. Meters should be installed on all connections for industrial purposes, and for certain large premises.

Ratepaying Engineers Criticize Montreal Aqueduct Report

Consulting Engineers Vautelet, McRae and St. Laurent Said to Lack Justification For Recommending "Scheme No. 2"—Board's Report Shown to Agree With Previous Allegations Concerning the Work

ON Tuesday of this week, Montreal's ratepaying engineers submitted to the city authorities a memorandum commenting upon the Montreal Aqueduct report recently made by Consulting Engineers Pautelet, McRae and St. Laurent. The memorandum is signed by W. F. Tye, John Kennedy, Ernest Marceau, J. A. Jamieson, R. A. Ross, Arthur Surveyer, and Walter J. Francis, who are a committee representing the thirty-one ratepaying engineers. W. F. Tye is the chairman of the committee, and Walter J. Francis the secretary. The memorandum, which was read and approved on July 5th, at a meeting of all the ratepaying engineers, is as follows:—

Following the receipt of your letter of 25th May, 1917, undertaking to let us have details of the estimates in the report of the Board of Engineers, dated April 30th, 1917, we have recently received from the City Hall certain pages of details of the report. Having studied these in conjunction with the report, we now beg to submit our comments thereon, as promised.

Summing up our conclusions, we may say that to us it is evident that the report of the Board of Engineers agrees in almost every main conclusion with our report submitted last November. The following contentions of our report are clearly supported:—

(*a*) The project as designed is condemned.

(*b*) Ice troubles are admitted to the degree that it is estimated the plant will be completely shut down for an average yearly period equivalent to 2.4 months.

(*c*) Radical changes in design, at greatly increased cost, are shown to be necessary to obtain the amount of power claimed by the city.

(*d*) Purchased power or steam-generated power is shown to be much cheaper than that which could be produced by the aqueduct.

(*e*) No power from the aqueduct would be available for lighting the city.

(*f*) The capital costs and annual charges are shown to be greatly in excess of the estimates made by the city.

The following is a brief comparison of statements made regarding the various features of the Montreal Aqueduct Power Development Scheme. The first paragraph in each case is based on published statements by the city up to the end of 1916. The second is based on the "Report by Ratepaying Engineers," dated November, 1916. The third is based on the "Report on Aqueduct Enlargement, Montreal Waterworks," by the Board of Engineers, Messrs. Vautelet, St. Laurent and McRae, dated April 30th, 1917.

Power Obtainable from Enlarged Aqueduct in E.H.P.

The City—Winter minimum, 9,000; summer minimum, 18,000; yearly average minimum, 14,000.

The Ratepaying Engineers—Maximum as designed, 7,000.

The Board—"Winter, 5,600; summer, 8,900." With radical alterations and additions, 9,750.

Probable Ice Troubles in Operation.

The City—Stated frequently that there would be no ice troubles.

The Ratepaying Engineers—Stated that "serious operating troubles due to ice are inevitable."

The Board—States that there will be ice troubles, "equivalent to a complete shut-down for 2.4 months each year."

Capital Cost of the Project.

The City—variously stated the cost from $2,500,000 to $9,500,000.

The Ratepaying Engineers—Gave the cost as over $10,600,000. (All data for complete estimates were not then available.)

The Board—Gives the cost as over $10,600,000, but did not include in the cost certain important items amounting to about $1,400,000, which would make the total cost at least $12,000,000.

Annual Unit Cost of Power from Aqueduct.

The City—Variously stated cost from $13.33 to $40 per horse-power per annum.

The Ratepaying Engineers—Said this cost would be $108.00 per electrical horse-power per annum, including sinking fund and depreciation.

The Board—Gives this cost as $56.90 per theoretical horse-power. (This is equivalent to $76.00 per electrical horse-power. In this cost the board does not include sinking fund and depreciation. It is based on a capital cost of $10,600,000. Based on a capital cost of $12,000,000 and including sinking fund and depreciation this annual unit cost is over $100 per electrical horse-power.)

Study of Project as a Whole.

The City—Frequently stated that project had been studied as a whole.

The Ratepaying Engineers—Always stated that "project had never been studied as a whole."

The Board—Would not answer this question when put by Mr. Commissioner Villeneuve.

The Necessity for the Undertaking.

The City—Undertook the present project and declared it very advantageous.

The Ratepaying Engineers—Stated that "the capacity of the original aqueduct was sufficient for three times the present population served, if used for water supply only, and not for hydraulic power," and also that "the present project should never have been started."

The Board—Says: "Had the old aqueduct been left as it was, simply as a supply to the steam pumps, a steam plant would have been a most attractive proposition."

Proposed Completion of Work.

The City—Persists in continuing, extending and completing the work in spite of protests.

The Ratepaying Engineers—Stated that "all thought of completing the project, along the present lines, should be abandoned."

The Board—States that the present scheme "is the one to which exception has been taken, and we agree that it should not be proceeded with as outlined. It could not have developed the expected power." The Board does

not recommend completion of the project, even after radical modifications.

Solution of the Problem.

The City—States that aqueduct power is the cheapest and best, and recommends completion of project.

The Ratepaying Engineers—Demonstrated the economy of abandoning the project as designed, making the most advantageous use of the work done and purchasing the balance of power or generating it by steam power.

The Board—Does not make any definite recommendation for the solution of the problem, except that firm bids on electric power be asked for.

Possibility of Lighting from Aqueduct.

The City—Stated that power from the aqueduct would be available for lighting the streets, with a surplus of power for sale.

The Ratepaying Engineers—Showed that lighting the streets with power from the aqueduct is impracticable

The Board—Shows that no aqueduct power would be available for lighting streets.

The above comparison shows a general concurrence by the Board of Engineers with the conclusions of the Ratepaying Engineers.

It is important to note that:—

(*a*) It was only after the protest by the Ratepaying Engineers in April, 1916, that the city began serious studies of the whole project.

(*b*) After the report by the Ratepaying Engineers in November, 1916, the City proposed radical changes in design at additional cost, to meet some of the objections raised. The Board's investigation and report shows that further changes in design must be made involving over a million dollars additional cost before the amount of water power claimed by the city could be approximated.

(*c*) The project as proposed by the city is strongly condemned by the board.

(*d*) The whole project has become so badly muddled that, after a long investigation, the board is unable to recommend a definite course of action, but merely recommends asking tenders for electric power and making further studies.

The resolution of February 6th, 1917, appointing the board, called for a comparison between the report of the ratepaying engineers made in November, 1916, at the request of the city council, and the different reports of the city engineer. This comparison has not been made.

This resolution stipulated that a complete study of the proposed development was to have been undertaken, and a report made "as to whether the development is feasible, practical and advantageous, and to advise the city on its advantages and disadvantages, with every recommendation which they (the Board of Engineers) will judge proper to make to the city." It cannot be said that this has been done.

Commissioner Ross' letter to the Board of Engineers dated February 16, 1917, apparently advised the board to disregard the reports referred to in the resolution of February 6th, 1917, but suggested that the board advise the city as to the right and wisest course for the city now to follow from a business point of view. The board apparently accepted this letter from one of the commissioners as instructions over-riding a resolution of the city, but failed to make definite recommendations as to the right and wisest course for the city to follow.

In the report and the detail figures sent to the city by the board certain items are omitted which are clearly chargeable to the capital cost of the aqueduct enlargement. The excess costs of the present steam pumping over that formerly done by the old aqueduct from 1907 until the completion of construction work, the repairs to the lateral conduit after the break in 1913 which was due to the construction work on the aqueduct, the emergency water supply from the Lachine Canal in this connection, the cost of ten bridges, and certain interest charges during construction, in all amounting to about $1,400,000, are omitted. This makes the total cost $12,000,000. This figure might easily reach $14,000,000 if the cost of all work on the boulevards be included and if any substantial portion of the claims of the Cook Construction Company be allowed.

In comparing the annual unit costs of power purchased with the unit cost of power developed, the board does not place them on the same basis for comparison. The only proper basis for comparison is for power available as "electrical horse-power" delivered on the switchboard at the Atwater plant, whether produced by the water in the aqueduct, or purchased in the ordinary commercial way as electrical power, or produced from a steam-electric plant.

As shown in the board's report, only three-quarters of the theoretical water power is available as electric power at the switchboard after deducting the various losses through the water-wheels and generators, and therefore in making a comparison with purchased power on a unit basis only three-quarters of the theoretical water horse-power should be considered. In the table of unit costs, the cost under Scheme 2 is given as $56.90 per theoretical water horse-power per year. This is equivalent to about $76 per electrical horse-power per year. In the same table purchased electrical horse-power at $25 gives a total annual unit cost of $62.47 per electrical horse-power, or, on a proper basis of comparison, a difference of nearly $14 per horse-power per year in favor of purchased power. This practically agrees with the relation of the total figures, where the total costs of developed aqueduct power under Scheme 2 are given as $740,000 per year and the total costs of purchased power are less and are given as $656,000 per year.

In the board's calculations of annual costs of power there is no provision made for sinking fund nor for depreciation. Based on the capital expenditure of $12,000,000 and with proper allowances for sinking fund and depreciation the total annual operating costs and fixed charges would amount to at least $1,000,000, equivalent to over $100 per electrical horse-power.

In view of the foregoing, there appears to be no justification for the statement: "Under ordinary circumstances and with the figures now before us, we would have no hesitation in recommending the adoption of Scheme 2 with provision for boulevards, as its cost of operation per horse-power per year is the lowest." If all cost items are included, either purchased power or steam-generated power is much cheaper than water power developed under Scheme 2.

A supplementary resolution of the city dated 26th February, 1917, voted an additional credit to the board on the understanding that the board was to answer questions submitted in writing by commissioners or aldermen. Commissioner Villeneuve, whose various published commentaries on the aqueduct question during the past year have shown his great interest in this important matter, submitted seven questions on April 30th, 1917, with a definite request for specific replies. In a letter dated May 10th, 1917, submitting their report to the city, the board

(Concluded on page 44.)

CEMENT-GUN CONSTRUCTION METHODS.

By Bryan Cheves Collier, M.Am.Soc.C.E.,
Chief Engineer, Cement-Gun Co., Inc.

WHEN the cement-gun first came into use, about 1910, it was thought that it would be necessary to apply its product, "gunite," on boards or other hard surfaces, but recent developments have shown that this is not only unnecessary, but is an additional expense. This article will review a few examples of how the best results have been obtained in this comparatively novel form of construction, with respect particularly to the construction of walls for various purposes.

The accompanying illustration gives two views of a hollow-tile structure, on which a coating of gunite was shot to a depth of about one-half inch. In order to insure a surface of absolutely true planes, it was found advisable to set "ground wires," which are merely fine wires drawn taut to insure a uniformity of deposit on the part of the nozzleman. A screed, made up (in various lengths) of a ⅞-in. x 6 ft. plank, with one edge chamfered and reinforced with a sharpened piece of thin steel plate, in the manner of an ordinary desk rule, was then used for the purpose of cutting to this true plane. This screed will easily cut through the gunite after it has been in place a few minutes. The surface which has thus been trued can be finished in several ways: by applying a thin second coat (either standard brands or white cement or of some of the Oriental stucco effects) with the gun; floating by hand with a mason's wooden float, shod with a piece of carpet; by stippling; by pebbledash; or by any other method.

The same methods employed here can be used in the renovation and reconstruction of old brick or concrete buildings, with the exception that it will be advisable first to sandblast the building (using the gun as a sandblast machine) in order to remove all loose or extraneous materials.

If it is desired to cover an old frame building with gunite, this can be done by first tacking tar-paper over the building, and then attaching with staples a light reinforcing mesh, such as heavy poultry wire, in such a manner as to prevent the wire being placed directly against the paper, and then shooting the gunite and proceeding as noted.

A method employed by the authorities of the Hospital for the Insane at Whitby, Ont., was of similar character, substituting new sheeting for the old wooden covering. In this work, however, a metal lath was used as reinforcement instead of the ordinary wire fabric.

In placing gunite over wood, marked attention must be paid to the advisability of covering the wood with a paper prior to attaching the reinforcing mesh, because otherwise not only does the wood tend to absorb the moisture from the gunite prior to its getting a set, but also the wood shrinks away from the gunite as its accustomed moisture is excluded.

An illustration of this occurred recently in some buildings erected in Cuba. The owners complained that they were not getting satisfactory results. Upon investigation, it was found that they had shot gunite on sheathing made up of green lumber, and without paper covering, with the result that the boards were shrinking and cracking the gunite.

However, the most satisfactory method of wall construction is obtained by attaching directly to the framework of the building (whether of truss or simpler construction) a reinforcing mesh of weight dependent on the span and thickness of the slab, and covering this with from three-quarter inch to two inches of gunite. Care should be taken to see that the reinforcing mesh is furred away from the frame in order to insure its being entirely covered. Inasmuch as the theory of gunite walls is based on the principle of reinforced concrete, the mesh should be near the inner side of the slab.

Two methods are employed in placing the gunite slabs: either by standing a panel along the plane of the outer face of the wall and shooting the gunite from the inner surface; or by attaching a tar-paper of at least two-ply thickness to the frame, to act as a form, and shooting against this from the outside. If the latter method is used and it is desired to obtain a wall of artistic finish, similar methods to those noted previously must be employed, but it should be noted that an experienced nozzleman can produce an excellent surface without the aid of a mason. The tar-paper serves the twofold purpose of at the same time providing a form for the gunite and aiding to keep the wall drier.

In work of this type, especial attention is called to five cardinal principles:—

1. The tar-paper must be drawn tight and be held firmly.
2. The wiring must be drawn to as near a true plane as possible, and it is for this reason that light, expanded metal offers a better method of reinforcing than any other. All reinforcement should be mesh of no less than 1½ inches.
3. The reinforcing mesh should never break at the corners, but should be carried around the corner in a sharp bend for at least one foot.
4. The reinforcing mesh should always lap at least six inches.
5. The mesh should be doubled by the addition of a small strip under and over the corners of windows and doors. This is a precaution to insure against cracking at this weakened point.

Another matter that merits careful consideration is the proportions in which the materials should be mixed. In Los Angeles, Cal., a firm of contractors who have specialized in cement gun work recommended the use of a mortar made up of one part cement and four parts sand with the addition of about ten per cent. of hydrated lime. They claim that in their climate they have obtained, by this mix, walls that are freer from checking and cracking than by any other. In addition, they use a small amount of hemp fibre (old rope cut in very short lengths) to each batch, claiming that thereby they aid against checking.

At the Hospital for the Insane at Whitby, Ont., the buildings have been covered with a mortar made by using one part of a mixture of 80 per cent. alco (hydrated) lime and twenty per cent. cement with two parts of sand. Excellent results were obtained with this mixture. In most cases, however, it has been the practice to use a mixture of one part cement, to which can be added not over 10 per cent. hydrated lime to three parts sand. This mixture insures a wall that is absolutely impervious.

It is a well-known fact that shrinkage is the cause of the larger percentage of cracks in walls; it is also known that shrinkage is much greater the more water is added; and, since the cement-gun offers the opportunity of placing mortar with only the proper amount of water by using the above precautions, and after determination as to which proportions of mortar mixture insure the best results in the climate considered, a wall

can be produced which will not only be fire and damp-proof, but also of indefinite life.

An illustration of methods used in the case of larger panels in walls is that of the coal car thawing shed built for the P. and R. Railroad at Port Reading, N.J. This building is an all-steel frame, covered with gunite, without and within; and in addition, the walls are provided with an inside coating wall, which procured two air spaces for insulation. The columns are spaced about six feet apart, connected only with tie-rods.

As a two-faced wall was called for, it was necessary to shoot one side without the use of a panel. It was, therefore, decided to shoot the outer wall from the inside and against a panel. The reinforcing mesh was attached directly to the channels, the movable panel furred away the proper distance and the material shot on. The middle wall was built up by hanging a tar-paper over the tie-rods, which were on the centre line of the channels. Over this a very light reinforcement was hung and one-half inch of gunite shot on. The inner wall was built up by first attaching a reinforced tar-paper directly to the columns, after which the reinforcing mesh was hung and then the gunite shot directly against the tar-paper In this way the double insulation was assured.

In shooting roofs, expansion joints may or may not be used. Experience has shown that long roofs have been shot without expansion joints and with perfect success, care being taken to see that the edges and valleys are doubly reinforced. In other cases, however, expansion joints have been deemed necessary, in which case they can be made very successfully in the following manner:—

Stretch the reinforcing mesh in place over the rafters, taking care to see that this mesh is turned up vertically at the proposed joints. As roofs are usually shot from underneath, it will then be necessary to provide a square edge on the panel against which the shooting is done in order to cover this vertical wire. Prior to shooting the adjacent section, several layers of tar-paper or felt are placed against these vertical joints, thereby preserving a space between the two sections. This leaves a "standing joint," which is then covered with a cap of some type (either reinforced gunite or metal).

The panels against which the material is shot from below usually consists of light boards which can be easily removed. This lower coat is shot only to such thickness as necessary to insure stability, when the finish coat is added from above.

The following are some authoritative costs:—

West New York Farms Company, 15 buildings, 1,478 square yards covered:—

	Cents per sq. yd.
Labor	4.47
Tending cement-gun	3.70
Sundries	3.40
Repairs	2.60
Cement	13.77
Sand	7.81
	35.75
Mason	8.50
Total	44.25

The following letter was received from the engineer in charge of the Whitby Hospital work and shows costs on that job:—

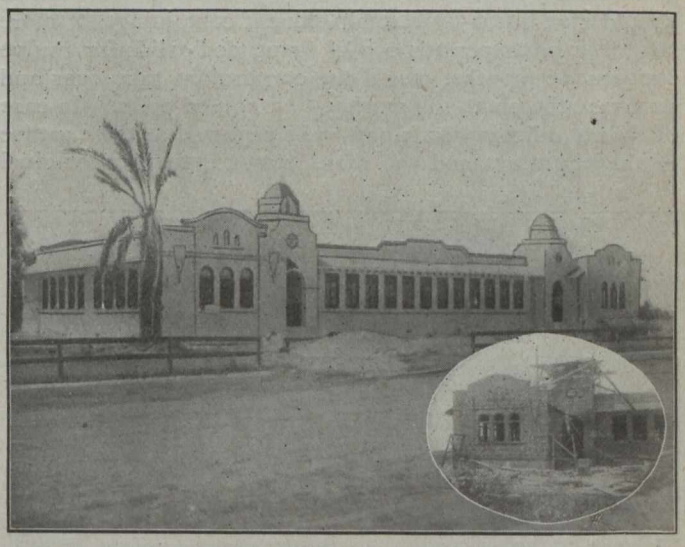
"Gunite on exterior walls is done in two coats and has a total thickness of ¾ inch. Nearly all this work is done from a swinging scaffolding, and our cost per yard covers the raising, lowering, etc., of same. Our average cost for all outside stucco done this season was 58 cents per square yard. The first coat costs on an average 49 cents and the splash or finish costs 9 cents.

"The wages we pay are as follows: Foreman, 55 cents; plasterers, 50 cents; nozzleman, 50 cents; unskilled labor, 30 cents.

"You will note that the price per square yard is arrived at after all openings have been deducted. We believe it is customary in the United States not to take openings into account at all, and, of course, this makes a considerable difference in the cost.

"If openings are not deducted, then our average cost per square yard for stucco is 43 cents.

"For interior plaster work our cost runs around



Gunite Shot Directly Onto Hollow Tile.

48 cents per square yard, with openings deducted; if openings are not deducted, the work can be done for about 40 cents. The material costs the same as for stucco and is applied by the same class of labor."

Recently a small-size cement-gun covered 160 square feet of wall an inch thick in thirteen minutes to illustrate the rapidity of operation of the machine.

Another illustration of how cheaply this new type of work can be done was shown recently when a building containing 800 square yards was completely covered in two days.

Bulletin No. 70 of the Bureau of Standards of the United States Government, issued January 31st, 1917, compares the mortar obtained by the cement-gun with hand-placed stuccos. A building erected in October, 1915, contains 57 panels, showing various stuccos over different substances. These panels were divided into groups. Group No. II. consists of five panels made up of cement mortar over wire lath. Of these five, the four hand-placed panels are rated in this report as "poor" and "very poor," while the gunite panel is rated as "excellent."

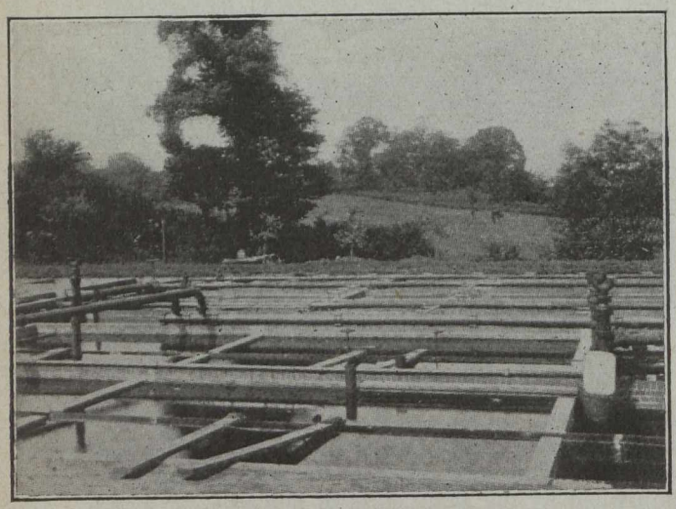
Report of Provincial Mines Branch shows the output of coal in Alberta this year to March 31st, to be one million five hundred and one thousand two hundred tons. The greater part of this was lignite from twenty-seven districts. Total production for 1916, four million six hundred and forty-eight thousand six hundred and four tons of coal, forty-one thousand nine hundred and fifty tons of coke, and one hundred and seven thousand nine hundred and fifty-nine tons of briquettes.

ACTIVATED SLUDGE PLANT AT WORCESTER, ENGLAND.

THE results of the experimental work which has been carried out at Worcester, England, for some time past demonstrate that another important advance in the treatment of sewage by the activated sludge system has been made.

In 1915 the city engineer of Worcester, Mr. Thomas Caink, recognizing the merit of the activated sludge system, on behalf of that city offered to Messrs. Jones and Attwood the use of a set of the sewage tanks for the carrying out of an experimental installation.

In making this offer, the city imposed a condition that Messrs. Jones and Attwood bear all the cost of the necessary engineering work, and only if they succeeded in treating 750,000 gallons of sewage each 24 hours which should give a non-putrescible effluent containing not more than four parts per 100,000 of suspended solids for twelve consecutive months, would the corporation take over and purchase the plant and works at an agreed price. In case of failure, all new work had to be removed at the expense of the engineers and the tanks restored to their original condition. So sure were the engineers that success would be attained that the offer was accepted and the alterations to the tanks commenced November 9th, 1915.



Looking Across Sludge Tank from Settling Tank.

The tank placed at their disposal was 80 ft. long by 72 ft. wide, made up in nine longitudinal bays each 8 ft. wide with 9-in. parting walls; these are again sub-divided into compartments with 9-in. transverse walls. Of the nine bays, five are used for aeration and agitation and four were adapted for settlement.

Aeration Tanks.

The five aeration bays are arranged as follows: The first bay, though 8 ft. broad at top, is only 5 ft. at bottom, due to batter of outside wall. The bottom of this first bay is arranged with ridges and furrows 5 ft. centre to centre, five aid diffusers each 12 ins. square were placed at the bottom of each furrow. The lower part of each transverse wall is cut away, making an opening 3 ft. deep right across tank above top of ridges, a ridge being arranged under each of these walls.

The other four aeration bays are aranged in pairs, each pair making a circulating tank. The bottoms of these circulating tanks are formed with ridges and furrows saw-tooth form at 10-ft. pitch with eight diffusers in each furrow. Advantage is taken of the transverse walls, which are used as baffles, and these together with intermediate baffles of wood give a baffle alongside each line of diffusers, which check the back flow and allow the rising current of sewage to flow forwards, thus giving a horizontal circulation of 100 ft. per minute velocity, a circulation much more rapid than would be obtained by the natural flow of the sewage through the tank. The objects of this intensive circulation are to prevent the deposition of sludge and to secure equality of its diffusion.

Settlement Tanks.

To make the best use of the four bays for settling the sludge and drawing off a clear effluent, the aeration tank effluent was brought over a weir into a channel leading it to the end of the four bays, into which it flowed underneath a timber baffle about 8 ft. below the surface, the liquid having a horizontal flow for a length of 80 ft. over a floor area having slopes of 20 to 80 degrees from the horizontal, and finally flowing over the edges of, and into a concrete channel. Eight sumps were formed and fitted with 3-in. diameter air lifts to lift the settled sludge into the inlet channel.

Air Compressing Plant.

The air compressor, belt-driven by electric motor capable of developing 40 b.h.p., is of the Ingersoll-Rand horizontal type, which when running at 235 r.p.m. has a piston displacement of 615 cubic feet, and an actual delivery of 562 cubic feet, or a volumetric efficiency of 91.5 per cent. at a pressure of 10 lbs. per square inch, according to makers' test.

Considerable discussion has occurred in reference to the use of porous tiles for diffusing the air.

Before adopting the porous tile we tried some experiments with small orifices, but found they choked whereas porous tiles were apparently not affected to nearly the same extent.

Having decided on the use of porous material we spent many months during 1913 and 1914 testing every porous material obtainable without securing anything suitable, and finally decided to make our own, and since we found a satisfactory composition early in 1915 we have had no trouble in obtaining the required porosity, whilst the sludge is not easily drawn into the pores of the tiles, although often subject to the full hydraulic head of sewage in tank, the tile acting as a filter.

Trouble was found during some of the earlier experiments at Davyhulme in oil choking the underside of diffusers, due chiefly to the fact that air was drawn from high pressure sources, and the oil used had become carbonized, but if air is compressed to not more than about 10 lbs. per square inch, the temperature of compression is not sufficient to alter the nature of the oil and thus the liability to choke is small, provided the air compressed is clean. A little oil probably prevents growths as we have found none.

The following advantages of the porous tile diffusers for circulation over mechanical agitation fully justify their adoption:—

(1) There are no moving parts in the sewage.

(2) Compressed air is used for aeration, agitation, circulation and sludge lifting, one large power unit is more economical than several smaller ones.

(3) The air used for aeration provides also for agitation and circulation.

(4) The vertical and lateral circulation by numerous diffusers in a ridge and furrow tank is more effective than

(Continued on page 38.)

SOME PRACTICAL PROBLEMS IN FILTRATION PLANT OPERATION.*

By Lewis I. Birdsall,
Superintendent, Water Purification, Minneapolis.

IT has occurred to the writer that certain practical problems encountered by him during his experience in the management of mechanical filtration plants may be common elsewhere, and that, therefore, a description of some of these problems and their solution might be of general interest to designing engineers and superintendents of filtration.

Coagulant Piping.

One of the greatest problems lies in getting an ample supply of coagulant solution to the right place at the right time when it is most needed.

When the writer assumed charge of the new Rock Island filter plant in 1911 a 1½-inch lead-lined iron pipe carried the alum solution some three hundred feet to the far end of the coagulating basins, the pipe being laid under the water of the basin. The available head for producing the flow of alum solution was approximately four feet. It was soon found that this line would not carry the required amount of solution because of clogging of the pipe by deposits from the alum, and also because of entrained air. An hydraulic ejector was placed in the line, but while it served to remove the air it did not remove the deposits in the pipe.

More serious difficulties arose when the alum solution began to appear where least expected. Investigation showed leaks at the threaded joints where lead did not meet lead, and also at the bad spots in the piping where the lead lining was deficient. The line was mostly under water, so the difficulties were increased. Whole lengths of pipe were replaced, but the troubles continued.

The lead-lined pipe was replaced with a 2-inch composition conduit which was guaranteed to be unaffected by the alum solution. So it was, but when the water in the basin began to warm up in the spring the conduit expanded and broke at the joints. Expansion joints of rubber hose were inserted, but when cold weather came the conduit contracted and pulled apart. Lead and brass pipe were then tried, but these clogged up with deposits of slimy material.

Mr. C. R. Henderson, manager of the Davenport Water Company, then suggested the use of four-ply rubber hose, which was installed in fifty-foot lengths, and the troubles were eliminated. Whenever the hose clogged up it was removed one length at a time, trod upon to loosen the deposits and then flushed out with water under pressure.

It is only fair to state that recent information from Rock Island shows that fibre conduit is satisfactory when encased in concrete or other suitable material, and is not subjected to extreme changes in temperature.

All coagulant lines in the Minneapolis filtration plant were of 2-inch lead pipe with brass couplings laid with a slope of 1 inch in 10 feet on horizontal runs. The discharge lines from the solution pumps to the overflow tanks which supply the chemical feed controllers gave little trouble from clogging, but the gravity flow lines from the controllers soon began to clog up, as did the pipes at Rock Island. The long runs of lead pipe were difficult to remove for frequent cleaning, and it became more and more difficult to get proper coagulation.

It was decided in 1914 when making additions to the original plant to install open coagulant piping in place of lead pipe on horizontal runs. Consideration was given to open tile laid in concrete, and to a concrete channel; but the scheme finally adopted was 4-inch iron pipe open at the top, made by James B. Clow & Sons from plans prepared by Mr. W. N. Jones, erection engineer. The writer is again indebted to Mr. C. R. Henderson for the suggestion of open coagulant piping, which has solved all of the difficulties formerly experienced. It is readily accessible for cleaning and for painting several times each year with a high grade of graphite or asphalt paint. No leaks have occurred in the pipe during the three years that it has been in service.

The chemical composition of the deposit occurring in the alum lines at Minneapolis may be of interest. The following analysis of a sample was made in the laboratories of the General Chemical Company, Chicago.

$Fe_2 (SO_4)_3$	22.60 per cent.
$Fe (OH)_3$	23.11 per cent.
$Al (OH)_3$	24.93 per cent.
Si O	12.32 per cent.
H_2O	15.96 per cent.
Ca O	None.
Cl	Trace.

The high cost of brass has led to our using iron flanges for connecting lead to lead, or lead to rubber hose on the discharge lines from the coagulant solution pumps. The iron flange is pushed onto the lead pipe, the end of which is then expanded with a mandrel and bent over so that a lead to lead coupling is obtained at slight expense.

Chemical Solution Agitators.

The agitating devices for the chemical solution tanks were originally of the two-blade impeller type driven by a 3-inch by 13-foot hollow vertical shaft direct connected to a 1,720-revolution-per-minute, 2-horse-power motor. The high speed of the impellers produced excellent agitation of the solutions, but caused the bending of the drive shafts and armature shafts in the motors. Corrosion of the steel shafting and bronze thrust bearing made much trouble and a high cost of maintenance.

It was decided to reduce the speed of the agitators to approximately 600 r.p.m. by means of reduction gears to replace the 6-inch impeller blades with wooden blades three feet long, and to make stead bearings at the centre of the vertical drive shafts. These changes eliminated some of the troubles, but there still remained the corrosion of the bronze bearings and the steel shafts. Also the agitators were very noisy, the motors having been set on a steel deck supported by I-beams over the centre of the tanks.

The 4-inch hollow steel shafts were replaced with square oak shafts 4 inches by 4 inches, the two blades made of one piece of oak and having an upward thrust at an angle of 45 degrees from the horizontal. One horizontal motor of two horse-power and 1,120 revolutions per minute replaced the three vertical motors, and by means of shafting, clutches and worm drive, the speed of the impellers was reduced to approximately ten revolutions per minute. The blades of the impellers were lengthened so as to reach within six inches of the sides of the tanks. The results have been very satisfactory, the noise having been eliminated; one motor does the work of three; there is no more trouble with the shafts or impellers, and the solution is amply agitated.

*Abstracted from paper read before the Convention of the American Water Works Association, Richmond, Va.

Painting Concrete.

The inside surfaces of all concrete chemical solution tanks are kept well covered with a good grade of asphalt or graphite paint. It was found that the alum solution was dissolving the lime-stone aggregate and otherwise decomposing the concrete walls of the tanks. Graphite paint seems to give better service than asphalt, the latter gradually dissolving off.

The Æsthetic Side of a Filter Plant.

It has occurred to the writer that more attention might well be given by designing engineers to the æsthetic side of a water purification plant. By this I mean, giving to the inside of a filter plant an appearance of light and cleanliness through the liberal use of white tile and paint. The added expense to the municipality or private water company would be more than offset by the favorable impression created in the minds of the water consumers, who in Minneapolis, for example, visit the plant to the number of ten thousand yearly. Most filtration plants present a creditable appearance externally, proper attention having been given to architectural design and landscape gardening. But inside the plant it is usually gloomy and oppressive to the casual visitor.

Sterilization of Distribution Mains.

Sterilization by means of hypochlorite of lime of all distribution mains larger than 12-inch following their installation and previous to their being placed in service is now practised in Minneapolis with gratifying results.

Liquid Chlorine.

Hypochlorite of lime was formerly used at Minneapolis in conjunction with filtration. At first the hypochlorite was added to the water upstream from the filters, but it was found that tastes and odors appeared in the filtered water during the summer months. The hypochlorite was then added to the filtered water and fewer complaints resulted.

In November, 1915, because it was found impossible to secure a year's contract for hypochlorite, liquid chlorine treatment was substituted for the hypochlorite. Three Wallace & Tiernan chlorine machines were installed, and as a result we would never again return to the use of hypochlorite if it were possible to avoid it. There have been no complaints of taste or odor arising from chlorine treatment since we began using liquid chlorine.

A decision was made to re-design the strainer plate system, making the plates heavier, increasing the size of the holes in the plates from 1/16 inch to 3/32 inch and reinforcing the plates with bronze ribs. Inquiry was made from various users of naval bronze and all agreed that the best grade of Tobin bronze should be adequate for the city's needs. The plates and bolts were then ordered made according to plans and specifications rigidly drawn by the designing engineer and approved by City Engineer Cappelen.

The new plates and bolts were properly installed in one filter unit, and the filter placed in service. Breaks occurred, and upon investigation it was found that the bolts in the centre plates had failed. A few of the plates also had cracked.

All bolts were then tested in tension by a dead load of 800 pounds. Bolts tested to failure in a testing machine straightened out at a load varying from 1,420 lbs. to 1,350 lbs. Other bolts bent through 180 degrees flat on themselves showed no fracture of the bent portion. The bolts tested to failure gave a unit tensile strength varying from 71,000 to 100,000 lbs. per square inch. Carefully tested and inspected bolts and plates were then replaced in the filter and the filter put in service. Failures again occurred.

A new lot of bolts was then heated in a furnace to a cherry red, quenched in luke-warm water, tested to 600 lbs. and put in place. They lasted about four weeks.

Strainer plates next began to fail. Laboratory tests were made to determine the effect of temperature changes upon the metal, also of electric currents, and of the water in the filters. These tests seemed to have no effect whatever upon the metal, which appeared to be sound. The mercuric chloride test was applied but without any result.

The company which made the plates and bolts suggested that possibly the cold working of the metal in making it up into plates and bolts might have caused a rearrangement of the molecules. They suggested annealing the metal. Therefore, enough plates and bolts to equip one filter were heated in a furnace to a cherry red for one hour, then removed and slowly cooled. These plates and bolts were then placed in a filter and the filter put in service. The results were very gratifying, no breaks occurring. The rest of the plates and bolts were then annealed in the same manner and after inspection and removal of any cracked ones, were placed in the filters. Only a few scattered failures have since occurred.

The medium brass plates and bolts installed in the filters have shown no failures whatever. Monel metal plates and bolts likewise having been used in one filter have shown no failures. All of our troubles were confined to Tobin bronze.

The U.S. Bureau of Standards made an investigation of the molecular structure of plates and bolts that failed and likewise of similar material that had not failed. Their conclusions, based upon these investigations and on investigations of naval bronze failures elsewhere, are that the cold working of the metal and too little attention paid to annealing cause considerable internal stresses, which are responsible for the above failures. It appears probable that hereafter monel metal will be used for strainer plates and bolts at the Minneapolis filtration plant.

RAILWAY EXPANSION IN MALAY PENINSULA.

Notwithstanding the turmoil in Europe, the British authorities in the Malay Peninsula have been steadily pursuing a progressive policy of railway extension, which has been retarded only by the difficulty of obtaining supplies of ironwork from the United Kingdom.

Under the treaty of 1909, which transferred the Malay States of Kedah, Perlis, Kelantan, and Trengganu from Siamese to British suzerainty, the Federated Malay States authorities agreed to lend a sum of £4,000,000—afterwards increased to £4,750,000—to the Siamese Government, to enable Siam to extend the State Railway southwards to form connections with the Federated Malay States Railway at the frontiers of Kelantan on the east and of Perlis on the west. The work has made steady progress, and is rapidly nearing completion. On their part, the Federated Malay States Railway authorities have been pushing on the extensions northward, through the western States of Kedah and Perlis, and recently Mr. P. A. Anthony, the general manager of the Federated Malay States Railways, accompanied by some members of his staff, and Mr. H. Gittins, the chief engineer of the Siamese State Railway, made the journey by train from Bangkok to Prai, on the mainland, opposite to the island of Penang, by way of Bukit Mertajam, the junction in Province Wellesley. The party was thus the first to make the journey over the new railway connecting Singapore and Penang with the capital of Siam.

ELECTROLYSIS IN UNDERGROUND WATER PIPES.*

By Jos. W. Ivy, C.E.,
Manager, Kansas City, Mo., Branch of American Cast Iron Pipe Company.

VERY soon after electrically operated railways were introduced into this country underground piping systems began to show damage from electrolysis. Prior to that time little or no trouble had been experienced. With the multiplication of electric car lines the situation has become more serious, and to-day the problem is receiving much attention at the hands of the Government Bureau of Standards, various engineering societies, and other interested organizations. It will be the purpose of this paper to deal only with electrolysis as affecting underground piping in water systems. However, before going into a discussion of this matter, it is desirable to briefly set forth the general principles involved and to define a few technical terms that will be used.

Terms and Definitions.

Certain solutions or chemical compounds are capable of conducting an electric current. Such solutions or compounds are called "electrolytes," and the transmitting of an electric current under these conditions is called "electrolytic conduction." This differs from ordinary metallic conduction—such as the passage of a current through a copper wire—in that electrolytic conduction is independent of any heating effect and produces chemical decomposition, whereas metallic conduction produces heat in the metal but does not otherwise affect it. This chemical change or decomposition produced by the passage of the electric current is called "electrolysis." A common example of this action and one of the forms in which it is usefully employed is the process known as electro-plating. The operation consists merely in passing an electric current through a solution of copper salt (or salt of whatever metal is desired), the conducting terminals—or electrodes—being of copper plate, copper is removed from one terminal and carried into solution and an equal quantity of copper is deposited on the other terminal. The terminal through which the current enters the solution is called the "anode," and the terminal at which the current leaves the solution is called the "cathode."

Electrolysis from Stray Currents.

(Anodic Corrosion.)

In this age of electricity there is abundant opportunity for electric current to leak into the soil from numerous grounded distribution systems. These are called "stray currents." For our purposes we need consider only stray currents that have leaked from the return conductors of ordinary street railway systems, the currents due to grounded telephone, telegraph and lighting system apparatus being negligibly small and not of sufficient strength to cause any serious trouble in pipe lines.

Most electric railways in this country employ direct current, the power being supplied to the cars through an overhead trolley wire and the return circuit to the power house being completed through the running rails. It is common practice to lay these rails with the tops flush with the street surface. Under such conditions the major portion of the rail area is in direct contact with the street soil, or where concrete has been used as a base, in contact with this. The water found in such soils (or concrete) usually contains salts, acids, etc., sufficient to make it capable of electrolytic conduction; hence either the wet concrete or wet soil is capable under ordinary conditions of conducting electric currents. Current from the return rails that flows or leaks into the soil or concrete must find its way back to the power house through some underground path. In doing so the current obeys the law of divided circuits, flowing through all possible paths in parallel, the strength in each being inversely proportional to its resistance. Underground water piping systems readily offered themselves as convenient conductors of these stray currents, especially where the rails cross, or parallel in close proximity the pipe. In general, these currents flow along the pipe until they reach the neighborhood of the power house, and at the nearest point to this leave the pipe, return through the soil to the rails, and thus back to the negative terminal of the generator. Where the current leaves the pipe and flows back to the rails the pipe serves as the anode, the soil as the electrolyte, and the rails as the cathode. These currents do no harm to the pipe except where they leave it, and at such points the pipe is corroded or eaten away. The extent of corrosion, or amount of metal destroyed is in keeping with Faraday's law, which holds that chemical decomposition occurring at the electrodes is directly proportional to the current flowing, the duration of flow and the chemical equivalent weights of the substances. The destruction of the metal is independent of voltage, except the determining effect of this on current flowing.

In addition to the damage occurring in the locality of the power house—which is by far the greater and more serious source of trouble—the pipe is also affected at other points where for certain reasons currents leave the pipe, either to shunt around some high resistance section or to return to the rails because of favorable soil conditions and possible close proximity of the tracks. Particularly in the case of cast iron, where there is a more frequent possibility of some lengths of pipe being of unusual high resistance, or the lead joints are so made that the pipes themselves are not in direct contact, the current flowing sometimes shunts around such high resistance pipes or joints. However, this is really an advantage rather than a disadvantage, because it exerts a strong tendency to keep the total current low, causing, as it does from time to time, a portion of what would be final accumulated current to leave the pipe and seek some other path, such as the rails, back to the power house. Obviously, in general, under these conditions the total current leaving the pipes at the power house is small—much smaller than the accumulated current would have been had there been no loss or leakage as here described. Wherever the pipe lines parallel the rails and pass through unusually wet soil there is more danger of serious trouble, such conditions lending themselves readily to the passage of current to or from the pipe or rails.

Under similar conditions with currents of equal strength flowing through iron pipes, the amount of metal destroyed is the same, whether the pipe is steel, wrought or cast iron. However, due to its inherent qualities and peculiar metallic structure, the resistance offered to the flow of electricity by cast iron is, roughly, ten times as great as steel or wrought iron, and the ordinary lead joints employed with cast iron increase this resistance materially, thus reducing proportionately the current

*Abstract of paper read at Southwestern Water Works Association Convention, at Topeka, Kan., June, 1917.

flowing, which makes the possibility of electrolysis in the case of cast iron approximately one-twelfth what it would be for the other two kinds of pipe mentioned. It should also be borne in mind that in practice cast-iron pipe has a metal thickness about four times that of wrought iron or steel, which proportionately delays the ultimate total destruction in the case of this class of pipe.

If pipe is of steel or wrought iron, results of electrolysis are seen in pits, these finally extending through the plate. Where the current leaves such pipe the metal is converted into iron oxide, which is frequently noticeable in surrounding soil. If the pipe be of cast iron, the oxides formed often are still held in position by the graphite, and the external appearance of the pipe remains unaffected. When the pipe has been entirely eaten through the mass is about the hardness of pencil lead and collapses under an ordinary hammer stroke, yet a pipe in this condition, if the soil is rather tightly packed about it, may remain without leaking for a considerable period. It is frequently necessary to make a direct physical examination of a pipe and subject it to a hammer test to determine if it has been attacked by electrolysis. So far, we have dealt only with trouble in the mains and distribution system proper. However, while less serious, probably the greater percentage of damage actually occurs in the service pipes, because these frequently pass under the car lines close to the rails, and the pipes being relatively thin, are quickly pierced. Investigation made in about fifty cities brought out the fact that, roughly, seventy-five per cent. of the trouble experienced occurred in the service pipes, lead, wrought iron or steel all being readily affected. Besides the damage to the service pipes themselves, stray electric currents flowing on these may occasionally reach the steel structure of buildings, causing electrolysis to attack the steel, but seldom to any serious extent. Under certain unusual conditions, current flowing on these service pipes may be sufficient to raise them to a temperature approximating red-heat, and in this way cause fires. In some cases of gas pipes, explosions have been brought about. However, such occurrences are undoubtedly very rare at the present time, and there seems no good reason to anticipate any increase in this hazard.

Electrolysis from Local Action.
(Self-Corrosion.)

In the preceding section it has been the intention to deal only with the effects of electrolysis due to stray currents, or what is usually spoken of as "anodic corrosion." That is action when the pipe serves as the anode, corrosion taking place only where current flows from the pipe to other conductors. Now, in addition to this form of electrolysis, we have what is termed "self-corrosion." That is, electrolysis by local galvanic action. This is termed "self-corrosion," for the reason that the current originates on the metal itself, and is due in the case of pipe to the impurities of the metal or the presence of carbon or coke in the surrounding earth, or both. Salts and acids in moist soil increase this action. Small pieces of coke or carbon in wet soil in contact with the pipe, even if no physical differences between adjacent parts of the metal exists, will bring about local action because a difference of potential will exist between the carbon and the iron, which will cause a current to flow from the pipe to the carbon. The potential difference existing under such conditions is approximately one-half a volt—causing a sufficient flow of current to bring about rapid deterioration. An instance of this kind came to the writer's attention where a large coated steel pipe passing through a cinder bed failed completely in a short time, the metal structure of the pipe becoming a mere honey-comb of rust. Self-corrosion is undoubtedly accelerated where anodic corrosion exists, galvanic action following as a secondary reaction. The primary action due to the stray currents produces iron oxide which is precipitated on the pipe exterior. This oxide acts just as a piece of coke in the case previously cited, bringing about a current flow due to the potential difference existing. The general effect of self-corrosion on iron pipes differs very little, if any, from the effects of corrosion by stray currents, the pipe being pitted and gradually eaten away, oxides form and behavior of these are the same. It is often very difficult to distinguish between the two actions. This has led to some disputes in an attempt to place the responsibility for electrolysis troubles, it being the practice in many cities to force the electric railways to pay for all the damage caused by electrolysis.

However, it should be stated that, in the case of cast iron at least, except where this is laid in excessively damp cinder beds or like materials, the local action is very seldom, if ever, sufficiently severe to cause the entire destruction of the pipe within the period of years usually ascribed to the life or usefulness of the ordinary pipe line. In other words, since practically all of the mains and distribution systems in the great majority of our cities consist of cast iron, there is not much trouble to be expected, except under unusual local conditions, from electrolysis other than that caused by stray currents that have leaked from electric railway systems. Owing to the present growth of the interurban lines, even many small towns and cities that have no street railway systems of their own, are no longer free of possible trouble from electrolysis. Hence this is a subject that demands attention from both towns and cities.

Mitigation of Electrolysis.

While it is not the writer's purpose, nor is it possible in the limited time and space assigned, to cover in detail the broad subject of electrolysis mitigation, this paper would be incomplete without a brief discussion of this and a mention in general of a few of the methods—good and bad—that have been tried to date. First of all, a more careful attention to proper bonding of rails would materially lessen the trouble by reducing in this way the leakage of current from the rails. Such a practice has been employed in European countries, particularly England and Germany. Many patented devices or so-called "mitigation systems" have been brought out and in some instances these have seemed to work out very satisfactorily. In other cases results have not been so good. Local conditions differ so widely that a system which might answer in one city would do very little good in another. The writer considers these systems still in the experimental stage. In this country many cities have attempted to lessen the evil by bonding at frequent intervals the pipe to the rails, employing some good conductor like copper wire in this operation. In most cases this method has been attended with only indifferent success and in the writer's opinion is more likely to prove a detriment than a help, because it is liable to increase rather than decrease the current leaving the pipe at points not in the neighborhood of the power house as the bonding would have a tendency to cause a larger current flow than would otherwise be the case.

From time to time in recent years a great many paints, dips, tar and fabric coatings and various so-called "insulating coverings" have been on the market and claims made of their worth, but so far, after extensive

experiments and practical tests, it is yet to be proven that paints, coverings, fabric and otherwise (except possibly asphaltum of one or two inches in thickness), are of much, if any, value. Tests made have only served to emphasize the fact that many of these coverings, such as pitch and burlap wrappings, increase rather than decrease the action of electrolysis.

Certain rather satisfactory results have been obtained by introducing insulating joints in pipe lines at proper intervals. Further developments along this line promise good results, provided experiments prove that the insulating joints can be inserted economically. Some cities have spent quite a little time and money in drainage experiments, their purpose, of course, being to remove as much as possible of the water from the soil and thus reduce the likelihood of electrolytic conduction. So far these experiments have not been productive of very good results and the opinion seems to be growing that the cost is excessive in comparison with results obtained. To sum up, so far the only method yet developed of securing absolute immunity from electrolysis is to perfectly insulate the return circuit. Several cities, notably, Havana, Cuba, and Cincinnati, Ohio, have accomplished this by providing an overhead return wire. Others have their return circuit through insulated underground conduits. At present a committee composed of leading men from engineering societies and kindred associations organized into what is known as the "American Committee on Electrolysis," are giving the subject of electrolysis mitigation very close study, and it is to be hoped that their findings, when made public, will go far towards settling this rather distressing problem.

Conclusions.

From the foregoing statements, and investigations made by the writer in the preparation of this paper, the following conclusions are drawn:—

(1) The possibility of electrolysis trouble increases as electric railways become more numerous and the loading becomes heavier.

(2) Stray currents are the principal and most troublesome source of damage. This damage is confined entirely to points where currents leave pipes.

(3) Anodic corrosion in underground pipe lines is directly traceable to currents that have leaked from imperfectly insulated return circuits of electric railways.

(4) The really serious damage to supply lines and distribution systems proper is confined in the main to the neighborhood of the power house, except under certain peculiar local conditions such as unusually wet soil, cinder beds, etc.

(5) Service pipes furnish the greater number of failures in a short period of time, and for this reason are generally regarded as the seat of probably seventy-five per cent. of the total trouble. Lead, steel or wrought iron all being readily attacked.

(6) The higher electrical resistivity of cast iron and the extra thickness of metal presented, greatly reduces the possibility of ultimate destruction in this class of material as compared with ordinary steel or wrought iron pipes.

(7) Self corrosion, except under extremely trying conditions, is seldom, if ever, sufficiently serious to cause complete failure of cast iron, though it might destroy iron of thinner structure.

(8) Paints, dips, fabric coatings, etc., are of little or no value in mitigating electrolysis. Fabric coatings especially rather tending to increase than decrease the damage.

(9) Better bonding of rails, introduction of insulating joints and like remedial measures have so far proven the most helpful in electrolysis mitigation.

(10) Only perfectly insulated return circuits offer absolute immunity from stray current damage.

(11) The Bureau of Standards, Washington, D.C., is glad to aid cities in the investigation and alleviation of their electrolysis troubles.

MR. LEA SAYS AQUEDUCT IS O.K.

The following letter was written by R. S. Lea, consulting engineer, Montreal, under date of June 26th, 1917, to R. D. Waugh, chairman of the Board of Commissioners of the Greater Winnipeg Water District:—

"Early in 1916, as you are aware, I was appointed a member of a Special Board of Consulting Engineers to examine and report upon the general question of the design and construction of the Shoal Lake Aqueduct. This was in consequence of certain defects which had developed in the previous (the first) season's work.

"In this matter I was associated with Brigadier-General H. N. Ruttan, late city engineer of Winnipeg, and Mr. J. G. Sullivan, chief engineer of the Canadian Pacific Railway.

"As a result of our investigation, covering a period of about six months, we reported that the materials and workmanship employed in the construction of the concrete aqueduct were of the highest quality, that the works, if carried out along lines indicated in the report, would, when completed, satisfactorily fulfil the purpose for which they were designed, would be of a substantial and permanent character, and would cost a sum which would compare advantageously with that of similar works elsewhere.

"The experience gained in connection with the 1916 and the present season's work, together with the lapse of a winter season, has served to confirm these conclusions, and to indicate that the defects referred to in the first year's work can be effectively repaired at a comparatively small cost.

"So far as my personal opinion is concerned, I can say that I have never seen a better example of concrete construction, both as regards workmanship and materials."

The scheme for the construction of a harbor at Vizagapatam has received the general sanction of the Secretary of State for India and the Bengal-Nagpur Railway Company is at present engaged in a detailed survey of the harbor.

The largest highway bridge in Nova Scotia is a six-span steel structure connecting the mainland of Cape Breton Island with Isle Madame. It is 2,500 ft. long overall, of which 1,400 ft. is earth embankment. There are three fixed spans of 200 ft. each and a swing span of 205 ft.

The Bureau of Standards, Washington, D.C., has undertaken to record the present state of knowledge and practice concerning the data on the properties of metals and alloys used by engineers and others, with the view of making generally available the most acceptable values of the constants. Forms are being sent out requesting the names of metals and alloys, conditions, chemical composition, etc. Some of the alloys for which data are particularly desired are aluminium and its light alloys with zinc, copper, etc.; nickel, monel metal, copper and nickel alloys, bearing metals, etc. The collection of the data should result in securing information which will be of value to manufacturers, metallurgists and all concerned with the making and use of alloys.

CANADA'S NICKEL INDUSTRY.

THE suggestion has been made in certain quarters that government ownership will solve many of the questions which have been raised in connection with the Canadian nickel deposits. The Royal Ontario Nickel Commission, appointed in September, 1915, by the Ontario government, to investigate the resources, industries and capacities of that province in connection with nickel and its ores, recently presented an extensive report. The commissioners point out that to expropriate the deposits and plants of the Sudbury nickel area would probably cost not less than $100,000,000, a sum approximately equal to the total paid-up capital of all the chartered banks in Canada. They add: "There is no certainty that large profits can be made every year from the nickel industry. The present activity is in part due to well-understood causes, which it is to be hoped will never recur. In the past the output has had to be curtailed at times. If the price of nickel should fall profits will naturally decrease. The nickel industry is to a considerable extent dependent for its success on the highly trained and specialized technical men who superintend it, who command salaries far beyond those which are paid in the government service to the most highly placed employees. Besides, nickel is not a necessity of life, nor an article of universal consumption or use, and the nickel business is in no way comparable to those connected with the operation of public utilities where government ownership may be beneficial or expedient. In short, there does not seem to be any good reason why the people of Ontario should be asked to adventure so large a sum of money as would be required for the purchase of the nickel deposits and plants."

After references to the various countries they visited, including United States, Great Britain, France, Norway, Cuba, Australia and New Caledonia, and to numerous mines, works, plants, smelters, etc., on this side of the Atlantic and on the other, and also to their interviews and conversations with Mr. Bonar Law, then secretary of state for the colonies, and other British government officials, the commissioners go on to say:—

"The two questions that have been uppermost in the numerous discussions that have taken place concerning Ontario's nickel industry during the last twenty-five years, are (1) Can nickel be economically refined in Ontario? and (2) Are the nickel deposits of Ontario of such a character that this province can compete successfully as a nickel producer with any other country? It will be seen that the commissioners have no hesitation in answering both of these questions in the affirmative."

The opening chapter of the report deals with the agitation which has gone on from the beginning of the industry in favor of the refining of nickel in Ontario, and various steps which governments or parliaments have from time to time taken to realize this desire. Also the negotiations with the Imperial government for the same purpose are summarized. The famous offer of the Ontario government to the British authorities in 1891, to give the latter a substantial, if not a controlling interest in the nickel mines of the province, if they would agree to establish refining plants and make nickel-steel here, is recalled. Doubt is cast, not upon the good faith of the offer, but upon the possibility of implementing it, if it included only the nickel deposits at that time remaining in the possession of the Crown. It is stated that most of the great deposits now being worked had already been parted with before the date of the offer. Nevertheless, the report says that the action of the government was a notable one, arguing remarkable insight into the future, and "had the offer been met with an equal degree of imagination on the part of Great Britain, it is not easy to say what the results would have been. Even with the deposits found since 1891 a good deal of nickel could have been obtained, and it could always have been possible to purchase privately owned properties."

The commissioners express gratification at the assured prospect of the erection in Ontario of two large plants for the refining of nickel.

One is now being constructed by the International Nickel Company of Canada, Limited, at Port Colborne. The company has obtained a site of 400 acres on which 2,000 men are now at work, and is erecting a plant whose initial output will be on the basis of 15,000,000 lbs. of nickel per annum, and provision is made for doubling or quadrupling this capacity. The matte to be refined here will come from the smelters of the Canadian Copper Company at Copper Cliff, and for the treatment of which there will be required bituminous coal, coke, fuel oil, nitre-cake, and other chemicals and materials, estimated at 100,000 tons annually. The plant is expected to be in operation and turning out refined nickel in the autumn of the present year.

The second refinery is that of the British America Nickel Corporation, Limited, a company controlled and largely financed by the British government, which has purchased the large Murray mine, the Whistle, and other deposits in the Sudbury region. This refinery will probably be erected at the Murray mine, which is about three miles from Sudbury. The refining process employed will be the electrolytic, otherwise known as the Hybinette process, from the name of the inventor who uses it in the Norwegian works. This plant will have a capacity at the beginning of 5,000 tons of nickel per annum.

As to compulsory measures for ensuring that the whole of the nickel output of Ontario should be refined within her borders, the commissioners say they are advised that the provincial legislature has not power to prohibit export or to impose an export tax directly, and that the power of the province in effect to regulate export by differential taxation in favor of nickel refined within the province, is a matter of grave doubt. The completion and operation of these plants, in the view of the commissioners, especially because of the probable extension of the facilities now being provided, will go far towards a solution of the question of home refining, which has so long exercised the public mind. The output of these refineries, added to the nickel now being produced in England from Ontario matte, will fully meet, if not surpass, the entire requirements of the British Empire.

A custom smelter for nickel ore has sometimes been suggested by individual owners of nickel deposits or small companies. The report states that the British America Company are prepared to consider this question and that if such an arrangement could be effected it would answer all probable requirements.

Ontario May Dominate Market.

The commissioners conclude that while it is true Ontario has no monopoly of nickel, it possesses many advantages over all competitors, even under the present conditions of the market as to prices and trade connections. In any keen competition as to prices it is doubtful whether any locality at present known or suggested could compete with Ontario. It is a matter of record that at one time of low prices the leading New Caledonia company was compelled to suspend its dividends. It may be doubtful, further, whether anything but an arrangement

of the market between the great interests can prevent the complete domination of the world's trade by the nickel industry of Ontario making the best use of its exceptional resources.

Prior to the war, nickel, in whatever country produced, was sold like any other metal wherever there was a market for it, and was treated solely as an article of commerce without regard to international relations. A schedule is given showing the countries in which the shares of the International Company are held. This covers 89,126 shares of preferred stock and 1,673,384 shares of common stock. The great bulk of the shares are held in the United States, Canada and Great Britain coming next. Only 256 shares of preferred and 452 shares of common stock are held in Germany and Austria.

The Mond Nickel Company operates on a smaller scale than the Canadian Copper Company. It works the Garson, Worthington, Levack, Victoria and Kirkwood mines, the ore from which it smelts at the plant at Coniston, erected two or three years ago. The matte is sent to Clydach in Wales, where it is refined by the Mond process, invented by the late president of the company, Dr. Ludwig Mond. The products of the refinery are metallic nickel, nickel salts, and copper sulphate. The market for the latter is in the vine-growing countries of Europe, where it is used to combat the enemies of the grape.

By-products from Sudbury Ores.

Some space is devoted in the report to a possible product from the Sudbury ores or slags, namely, nickel-copper steel. There has been a prejudice against the presence of copper in steel, but much recent experimentation has tended to show that this prejudice is unfounded, if the copper is not too high; indeed, there is reason to believe that the presence of a limited proportion of copper in steel is beneficial, and also that it is capable of replacing a proportion of the nickel in nickel-steel up to at least one-third of the combined quantities of nickel and copper. Experiments made for the commission by Professor Guess, of the University of Toronto, fully confirmed these conclusions. Copper also appears to assist steel in resisting corrosion.

The production of nickel as a by-product was investigated by the commission. Such production is of considerable importance. By-product nickel comes mainly from the electrolytic refining of Blister copper, copper ores almost invariably carrying a small proportion of nickel. About 815 tons of nickel were obtained in 1915 from the refining of copper from the United States, and the tremendous production of copper going on in the States will largely increase this quantity. In addition, scrap metal containing nickel is continually being re-treated and the nickel recovered. The production of by-product nickel, though small in comparison with the output of ores worked for that metal, has much bearing upon possible supplies of non-Canadian nickel for export to enemy or other countries.

Precious Metal Contents of Sudbury Ores.

The commissioners point out that the importance of the precious metal contents of the Sudbury ores has not in the past been fully recognized. These consist of gold, silver, platinum, iridium and other rare elements. The proportions of these metals which the ores carry are minute and appear to vary in the several deposits. Roasted matte from one of the companies showed .1235 ounce platinum and .119 palladium, .027 gold and 1.84 ounces silver, while the other company's mattes were: platinum, .988 ounce; palladium, .984 ounce; gold, .256 ounce, and silver, 6.155 ounces per ton. Platinum is at present very scarce and the price unusually high; palladium is being substituted for it wherever suited. Both these metals are now worth at least five times as much per ounce as gold.

The Orford refining process recovers a much smaller quantity of the precious metals than the Mond and electrolytic processes. The recovery of the metals of the platinum group constitutes an interesting chapter of the report. It states that the platinum and palladium contained in the Copper Cliff mattes for the year 1916 would be worth $794,600.

Inevitable Losses in Metal Production.

Losses in mining, smelting and refining are discussed in the report. These are stated to be considerable. Certain losses are inevitable at each of the successive stages of treating the ore. In mining, heap-roasting, smelting, converting and refining, such losses cannot be wholly eliminated. In smelting there is not much reason to anticipate that further savings of the metals can be made. The abolition of heap-roasting would make a small saving in nickel and copper. The whole of the sulphur in the ore must be got rid of and at present all goes to waste. The question of the possible recovery and utilization of sulphur fumes is given a chapter in the report. Fumes from the roast-heaps are most objectionable and injurious, and there is no means of collecting the sulphur given off from the heaps. A million tons of ore contains sulphur enough to make a million tons of sulphuric acid, but sulphuric acid can only be produced at heavy loss, since the freight charges to market on so bulky an article would cost more than the article is worth.

A chapter is devoted to statistics of nickel production, showing the output of Ontario, New Caledonia, Norway, and other countries.

The important subject of taxation is dealt with in the concluding chapter. The commissioners were instructed to report upon a just and equitable system for taxing, not only nickel and copper mines, but mines of all kinds. Their report is, that the present method of taxation on net profits is the fairest and best. In their opinion the present rate of 3 per cent. should not be raised beyond 5 per cent. Gold mining companies occupy a unique position; their product has a fixed price of $20.67 an ounce, and while all other metals have advanced, some of them very materially, the gold companies get no more for their product than before, yet their costs are largely increased by the higher prices for labor and cost of supplies.

The Royal Ontario Nickel Commission is composed of the following members: Geo. T. Holloway, associate of the Royal College of Science, London, and vice-president of the Institution of Mining and Metallurgy, and English metallurgical expert of high repute; Dr. W. G. Miller, Ontario provincial geologist; and McGregor Young, K.C., a well-known barrister of Toronto. Thomas W. Gibson, deputy minister of mines of Ontario, acted as secretary.

Exports of iron and steel from the United States during March, 1917, totalled 606,560 tons, against 438,150 in March, 1916.

It is expected that the East-West Transcontinental Railway of the Australian Commonwealth will be opened in September.

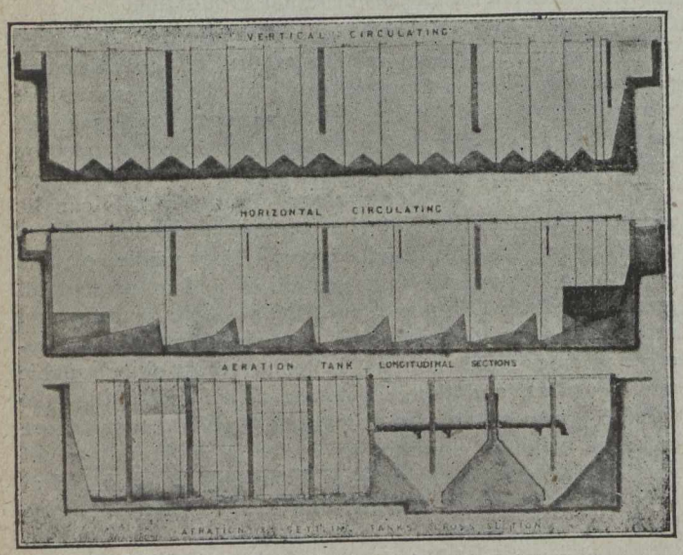
Sanction has been given to the construction of underground electric railways in Madrid. There are to be four lines, but only one—from Cuatro Caminos to the Plaza del Progreso, a length of 2½ miles—is to be built at present.

ACTIVATED SLUDGE PLANT AT WORCESTER, ENGLAND.

(Continued from page 30.)

any form of mechanical circulation. The sludge by means of the sloped bottom gravitates on to a diffuser, where it meets with an upward current of air and water and is carried rapidly to the top surface of the liquid, from which it falls slowly to be again carried to the surface. These numerous vertical whirlpools ensure the whole of the sewage being equally treated.

(5) In most cases where compressed air is used all the heat of compression is lost, and only a portion of the



Section of Tanks.

potential energy in the cold air is obtained in useful work. In the use of compressed air for agitation and circulation the whole of the energy contained in the air is given back.

The reasons for this almost ideal efficiency of compressed air when used for aeration are:—

(*a*) There is no back pressure as the air escapes at surface of sewage at atmospheric pressure.

(*b*) The energy in the air is used to produce motion in the liquid, and is therefore equivalent to the heat generated by that motion. Again, the work of the air expanding extracts an exact equivalent in heat from the liquid. Thus the two effects neutralize each other.

It was assumed that if air lifts are as economical as mechanical mixers, then the use of air for both mixing and aeration must make the air lift more economical.

The engineers therefore concentrated their attention in devising the most economical method of agitating by air lifts and the outcome was the diffuser arranged in furrows.

It is interesting to find this reasoning has been borne out in practice, and that diffusers are being adopted almost without exception in the activated sludge process.

On April 6th, 1916, tanks and plant were complete, and treatment began on the "fill-and-draw" method, draw-off valves for this purpose having been fixed and the wall between aeration and settlement tanks timbered to allow of filling the aeration tank alone.

The average length of aeration for each filling was about 8½ hours. The sludge was built up rapidly and in 31 fillings of 8 ft. 6 ins. depth each, the sludge amounted to 12½ per cent. of the full tank, this increase being at the rate of .57 of one per cent. of volume of sewage treated per day, and after 16 days' operation the effluent had an oxygen absorption figure as low as 0.94.

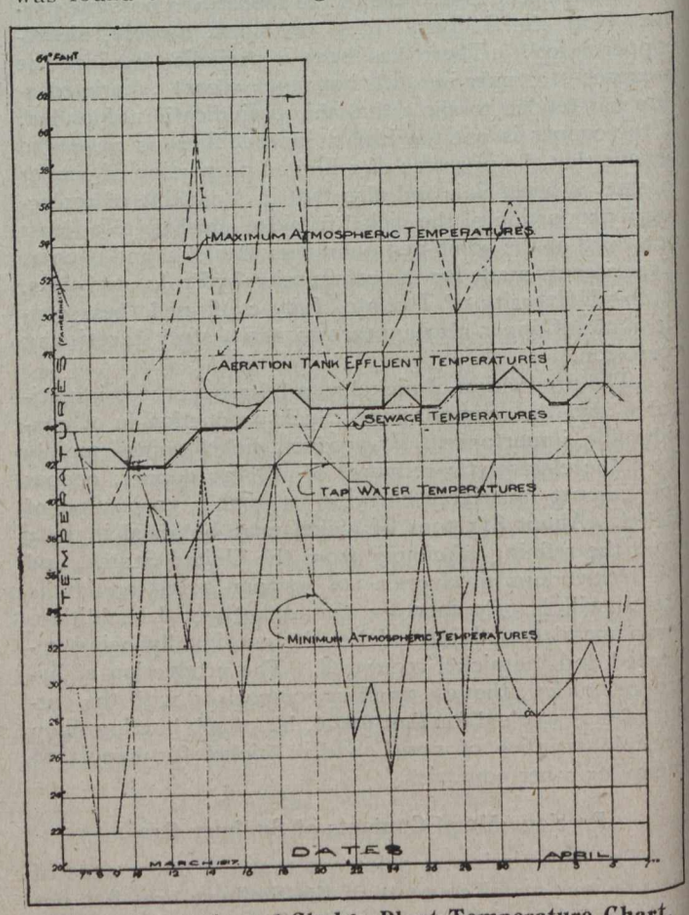
On April 24th "continuous flow" treatment was begun at the rate of 700,000 gallons (112,000 cubic feet) per day, and the settlement tanks were filled and brought into commission, sludge being withdrawn from the first set of tanks and returned to sewage inlet channel.

After three days' operation the result is shown by the following analysis:—

Table No. 1.

		Parts per 100,000		
Date, 1916	Character of liquid	Free and saline ammonia	Albuminoid ammonia	Oxygen absorption 4 hours
27 April—	Raw sewage ..... average of 24 hrs. samples taken at intervals of 2 hrs. Fairly clear; some dark flocculent sludge; no solids.	.92	1.8	2.21
27 April—	Effluent ..... Bright, clear; no solids, no smell; slight trace sludge.	.92	.084	1.34
	Percentage of purification	Nil	95%	40%

This and other analyses showed a falling off in results, the quantity of activated sludge in aeration tank having diminished seriously. Much of the returned sludge was found to be collecting in the sewage inlet channel.



Worcester Activated Sludge Plant Temperature Chart.

The sectional area of this channel was reduced and the consequent increase in velocity prevented the deposition.

Sludge was also deposited on some of the slopes of the settlement tanks, where it rapidly became septic, and it was decided on May 5th to alter these.

During the alterations the water level in aeration tank was dropped about 12 ft. and the sludge kept active by daily aeration. This alteration was completed May 28th, and after treating 200,000 gallons (32,000 cubic feet) of sewage on the 29th while treating 250,000 gallons (40,000 cubic feet) on the 30th an analysis of the effluent gave the following:—

Table No. 2.

		Result in Parts per 100,000		
Date, 1916	Character of liquid	Free and saline ammonia	Albuminoid ammonia	Oxygen absorption 4 hours
May 30	Average raw 24 hrs. sewage ..... Opalescent; brown solids strong smell	2.48	.46	4.8
May 30	Effluent ..... Clear, bright, and smell; very few light solids.	1.38	.009	.58
	Percentage of purification	44%	98%	88%

The volume treated was gradually increased to 800,000 gallons (128,000 cubic feet) per day, when a sample was analyzed with the following results:—

June 9	Effluent	.6	.13	.4

Nitrogen in nitrates and nitrites, 1.3.

Dissolved atmospheric oxygen absorbed in five days, 0.8 parts.

On the 5th July, when treating 830,000 gallons (133,000 cubic feet) per day, the analysis of a sample yielded the following result:—

Table No. 3.

		Parts per 100,000		
Date, 1916	Character of liquid	Free and saline ammonia	Albuminoid ammonia	Oxygen absorption 4 hours
5 July	Screened sewage ... Opalescent; some sludge; strong smell; no solids.	3.2	.60	5.7
5 July	*Partially treated sewage at end of first bay ..... Very slightly opalescent; some sludge; no solids; faint smell.	2.00	.19	1.98
5 July	†Effluent after first settlement ..... Clear, bright; some sludge; no solids; no smell.	—	—	.68

Proportion of sludge in aeration tank = 16 per cent.

*Percentage of purification: Albuminoid ammonia, 68%; oxygen absorption, 66%.

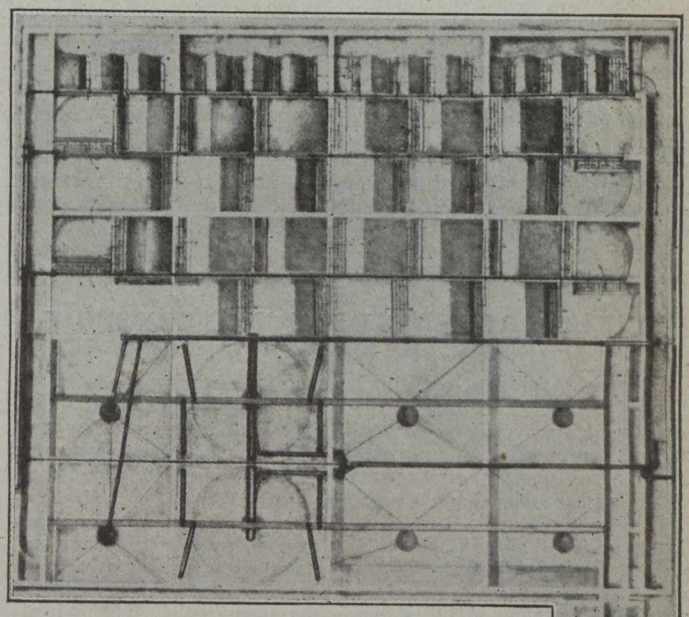
†Percentage of purification: Oxygen absorption, 88%.

Treatment was continued with slight interruptions (for enlarging the air lifts from 3 ins. to 6 ins., and fixing effluent collecting troughs) until December, 1916, at rates varying from 600,000 to 1,000,000 gallons (96,000 to 160,000 cubic feet) per day, but the first set of settling tanks in which all the settling was done was not able to pass continuously and successfully more than 750,000 gallons (120,000 cubic feet) per day of sewage, or including returned sludge, 1,000,000 gallons (160,000 cubic feet). Their capacity being 30,000 gallons (4,800 cubic feet), they afforded 57 minutes flow calculated on the 750,000 gallons (120,000 cubic feet) daily flow, or 43 minutes calculated on the total of 1,000,000 gallons (160,000 cubic feet).

The 6-in. air lifts together were set to raise 250,000 gallons (40,000 cubic feet) per day of sludge, but are capable of raising up to 400,000 gallons by further opening of the compressed air valves.

During a week's test from 20th to 27th October with a fairly constant flow of 750,000 gallons (120,000 cubic feet) per day of sewage, the average of suspended solids in the effluent was 3.4 parts and the oxygen absorbed in 4 hours test 1.13 parts per 100,000, results well within the requirements of the city. The proportion of activated sludge in a sample of sewage taken from the aeration tank and settled for one hour in a glass cylinder amounted to 11 per cent. at beginning, and 15 per cent. at end of the week's test, all sludge during the week being returned to aeration tank.

As the aeration tank appeared capable of treating much larger quantities, and that not more than 750,000



Plan of Aeration and Settlement Tanks.

gallons (120,000 cubic feet) of sewage per day could be settled in the first set of settling tanks if the suspended solids in effluent were to be kept down below 4 parts per 100,000, it was decided to alter the slopes of the second set of tanks and utilize them in the same way. This has now been done, affording an extra capacity of 40,000 gallons (6,400 cubic feet) for settling purposes.

It is interesting to note that no trouble had or has been experienced in connection with the aeration tank, which from the start has given excellent results, so that almost all alterations have been in connection with the settlement tanks to make them capable of dealing with the flow from the aeration tanks.

Purification Obtained.

The average of nine samples of screened sewage being all those taken and analyzed by the Worcester city analyst between July, 1916, and 19th May, 1917, gave the following results in parts per 100,000:—

Solids in suspension	14.3
Solids in solution	128.8
Albuminoid ammonia	.76
Oxygen absorbed in 4 hours	3.7

Since November, however, the more dilute sewage from the St. John's district has been omitted and a snap

sample taken 22nd May last of Worcester city sewage showed the oxygen absorbed figure to be as high as 9.74 and the albuminoid ammonia 1.48 parts.

The temperature diagram shown herewith is of especial interest as the temperatures were taken during a spell of cold weather; the lowest atmospheric temperature recorded is 22° F., or as low as usually experienced in a normal English winter.

It will be noticed that the temperature of the sewage was always higher than the temperature of the tap water, averaging 4° F. higher, and that the temperature of the effluent after aeration was never lower than that of the sewage, but on eight days it was actually higher. It will also be noticed that the greatest difference between the tap water and sewage temperature was during the coldest weather.

The diagram explains why spells of cold weather do not affect the character of the effluent materially, and further gives reason to expect that the process will be found more suitable for cold climates than exposed trickling filters.

TORONTO ENGINEERS REVISING BY-LAWS.

At an open meeting of the Toronto Branch held May 1st, 1917, it was moved by Prof. Haultain that a committee be elected to revise the by-laws of the Toronto Branch of the Cnadaian Society of Civil Engineers and to study means of increasing the prestige and influence of the branch. The executive committee of the branch now announce that in accordance with this motion they are prepared to receive nominations up to and including August 1st for members to serve on this committee. Nominations will be by mail and a committee of five members will be elected by letter ballot.

WINNIPEG AQUEDUCT WORK TO CONTINUE.

Mayor Davidson, of Winnipeg, and Commissioners R. D. Waugh and J. H. Ashdown, of the Winnipeg Water District, recently made a visit to Montreal on which they were successful in completing arrangements for the further financing of the Winnipeg aqueduct work. A syndicate having charge of the matter has been arranged by the Bank of Montreal and includes Wood, Gundy & Co., the Dominion Securities Corporation, C. Meredith & Co., and a number of other important financial houses. Arrangements are under way for a public offering of the bonds in the near future. Already a substantial portion of this issue has been sold. The Winnipeg Water District was created in 1913 to provide a suitable water supply for the city of Winnipeg and surrounding suburbs. The district has an area of 91.79 square miles, with an assessment of $226,492,739, and a population of 220,426. The bonds are secured by a direct charge on all of the land in the district, including the entire city of Winnipeg.

CORRECTION.

In the personal column of our issue of June 14th there appeared an item regarding Mr. J. W. Seens, manager of the Structural Steel Co., Montreal. *The Canadian Engineer* is in receipt of a letter from Mr. Seens stating that it is true that the Structural Steel Co. will discontinue operations during the present summer owing to expiration of lease of shop rented from the Montreal Locomotive Co., but that any information regarding his having joined the engineering staff of any other bridge company is decidedly premature, and it is unlikely that he will discontinue serving in his present capacity as manager of the Structural Steel Co., Limited, for some considerable time.

A $150,000 lawsuit has been brought against the contracting firm of Grant, Smith & Co., by the Seattle Construction Co., the amount claimed being for damage done to a floating dock which capsized and smashed while under use by Grant, Smith & Co. during the construction of the breakwater at Victoria, B.C. The case will be heard either in Vancouver or Victoria on September 17th.

CANADA FACED WITH COAL SHORTAGE.

"Canada is faced with a coal shortage of very alarming proportions, and by next winter, if conditions do not change, a great many industrial concerns and householders will be unable to supply themselves with sufficient coal to carry them through the cold weather." Such is the gist of a statement made in Montreal by Mr. A. D. MacTier, general manager of the eastern lines of the Canadian Pacific Railway. He continued as follows: "The present and prospective difficulties in the way of bringing coal into eastern Canada may be attributed to a number of causes, principal amongst which are dearth of mining labor and shortage of coal-carrying equipment at the mines. The situation in some of the mining territories at the present time is that, even with the labor shortage, mine operators are able to turn out coal at a greater rate than they can obtain cars to carry it away. It, therefore, naturally follows that more coal can be brought into Canada if the car supply is increased.

"Unfortunately, it is out of the question to obtain any number of new cars at this time, and the situation can be met only by obtaining more service from the present rolling stock. To do this, cars must be moved promptly between the mines and destination, and must be unloaded as soon as they reach consignees."

INDUSTRIAL CONDITIONS IN CANADA.

Labor conditions render it increasingly difficult to meet the continued heavy demand for munitions. Loss of time through trade disputes and desultory work are as great an obstacle to the full utilization of the country's industrial resources as the actual shortage in the supply of labor. Unless some more effective regulation of labor is introduced, which will bring about more regular and more permanent service, it may not be possible to sustain the present volume of exports of manufactured goods, essential as it is to the maintenance of our financial position. Labor and ocean transportation difficulties are, perhaps, equally responsible for the falling off in exports which were less in April by $21,000,000 than the imports for that month, the first unfavorable balance since February, 1915.

The reports of industrial companies recently issued show remarkable profits for the twelve-month periods which they cover, but it is noticeable that the output of coal is less and that strikes in that industry are having a far-reaching effect. In southern British Columbia an important smelting plant has been closed down since the first of May owing to the shortage of coke caused by the strike in the Crow's Nest Pass collieries, and at the end of May the prospects of a settlement were regarded as being somewhat remote. The indirect results of this strike are no less serious. Railways are handicapped by a shortage of fuel for their engines, and, consequently, the movement of freight is obstructed and business is affected in endless ways. The effect of recent strikes in the coal mines, in the shoe industry in Quebec, in the steel industry in the maritime provinces, in the mines of Ontario and elsewhere has been to cause a serious decrease in production. An undesirable result of the prevailing high wages has been that a few weeks of work is followed by a few weeks of holiday. Contrary to expectations, high wages have not in many cases contributed to labor stability or efficiency.—Canadian Bank of Commerce.

A new British coaling plant has recently been erected at Port Natal. The plant is stated to be the only one of its kind in South Africa, and it is claimed that it is one of the largest belt-conveyer installations at present in operation for coaling vessels. The plant was designed to load 600 tons of coal per hour. This result has been easily attained, and it is estimated that, under favorable conditions, it is capable of loading 1,000 tons per hour. Power is supplied by three 150 horse-power motors and nine of smaller capacity, supplying an aggregate of about 1,000 horse-power for the various operations of the plant. The main—horizontal—conveyer belt is 525 ft. long, and has a speed of 450 ft. per minute; a smaller—incline—belt is 230 ft. long. A feature of the plant is the care that has been taken to avoid undue breakage of the coal. A direct fall is obviated, and the coal is gradually lowered into the ship's hold.

Editorials

REGULATION OF PUBLIC EXPENDITURES.

Brantford's Board of Trade has appointed a national service committee, and that committee has forwarded to the Dominion government a number of recommendations, at least one of which appears to bear the germ of an excellent idea, viz., the organization of some central body through which the government, the provinces and the municipalities can co-operate in planning public works which will absorb a considerable number of returned heroes. This is decidedly a move in the right direction, and it is to be hoped not only that the Dominion and provincial governments will adopt the Brantford idea, but also that they will go much further and clothe the central body with authority to regulate all public work.

There are two reasons why some broad supervision should be exercised in regard to public works, not only after the war, but also during the remaining period of the war. First, the work should be spread so that in one place there will not be a shortage of labor and in another, acute depression owing to extensive unemployment. Former soldiers living in all parts of the country should be given somewhat uniform chance of employment without being required to leave their homes and relatives.

Second, and perhaps even much more important, the money resources of the lending nations and the bond-absorbing capacity of our own country should be conserved for the most necessary work; and an independent, impartial board should be the judge of the relative necessity.

In years past there has been little or no regulation of public works expenditures in Canada, probably because there was no need to regulate them. Money was generally most readily obtainable at low rates of interest. Any town or city that cared to obligate itself to levy a little higher tax rate for the next twenty, thirty or forty years could obtain large sums without effort, and dozens of bond houses would compete strenuously to buy the issue. Investment money that was accumulating throughout the world looked upon Canada with favor, and the bond dealers rarely failed to find a buyer for any Canadian municipals.

The war may materially change that situation for some years to come. It has changed it already; in fact, the change started even slightly before the declaration of war. Central regulation of public expenditure is necessary so long as these changed conditions continue. When money flows into Canada again without stint or effort, then regulation can cease, but that time may not arrive for several years to come, and meanwhile regulation is imperative. With Liberty Loans, Victory Loans, Domestic War Loans, etc., dredging the investment market almost to rock bottom, it is hard for municipalities to suck up enough to make it worth while keeping the pumps going.

A certain amount of money is still being invested in Canadian municipal issues, and a very generous amount, too, considering the many other imperative demands upon the money sources. Much work is being done with foreign capital and the savings of our own people. But some constituted authority should see to it for years to come that every dollar of investment money raised in Canada or brought into Canada for other than war purposes is put to really useful and productive work.

For instance, no large city, however good its credit may be, should be allowed to drain the money market of millions to be spent on unnecessary power developments or elaborate boulevard schemes while some smaller town nearby, with more limited credit, is forced to be satisfied with an outrageously polluted water supply because it cannot raise the money to construct a proper waterworks system.

A nation-wide civilian and engineering organization is needed to handle the situation and pass upon all plans and O.K. all expenditure before any bonds can be sold. Such a council should comprise representatives of the Dominion government, the provinces, the municipalities, the rural districts, the capitalistic and laboring interests and the military authorities, and should be advised by the very best obtainable boards of engineering, chemical, legal and financial consultants.

CHOOSING ROAD MATERIALS.

"There are many inalienable rights of the individual with which neither friends nor enemies have any call to interfere," says a recent bulletin of the American Highway Association. "He may wed a wife with the brains of a dead haddock and we cannot say nay, nor may we use more than verbal advice to prevent his early demise by eating a foundation of hot mince pie and a wearing surface of sizzling Welsh rarebit. But when he takes advantage of the right he possesses in many places to select the kind of pavement laid in front of his property, everybody has justification for raising strong objection.

"The road is for the public use, and even when a considerable part of its improvement is paid by local assessment the community contributes the remainder of the cost, and, therefore, should have a voice in determining its nature."

The average taxpayer is not a road expert; the ability to drive an automobile over a slippery pavement without skidding does not make him one, although it may make him a helpful critic. It takes years of study and experience to develop a road expert. He must know not only the method of constructing various types of roads under different conditions, but also the economical advantages and comparative merits of all the different types.

Sooner or later, he will be employed on every important road undertaking, and the beginning of his service should be at the outset of the work, so that his knowledge may guide the selection of the type of construction. To wait until the contract is let is to throw away a very large part of the help that he can give. No engineer can be held responsible for the behavior of a road unless all the steps that are taken in originating and carrying on the whole enterprise have had his approval.

PERSONALS.

H. R. GERRARD, for two and one-half years city electrician at Port Alberni, Vancouver Island, is now filling a similar position at Duncan, B.C.

Lieut. W. M. GOODWIN, of the Canadian Engineers, son of Dean W. L. Goodwin, of the Engineering Department, Queen's University, Kingston, has been awarded the Military Cross.

Prof. BORIS BAKHMETEFF, the Russian Republic's special ambassador to the United States, was recently elected a member of the Canadian Society of Civil Engineers, as mentioned last week in *The Canadian Engineer*. In an address before the United States Senate, Ambassador Bakhmeteff said that Russia would make no separate peace with Germany. "Our national convention," he announced, "will be called as soon as possible. There will be about a thousand delegates, and the machinery of election is now being arranged by a non-political commission of about sixty Russians. The delegates will be chosen by universal, direct, equal and secret suffrage. All over the age of twenty will vote, regardless of sex or creed or race. Each voter will vote direct for his or her choice and not through an elector. The voting rights of all will be equal, regardless of property, and the ballot will be secret. A mistake that has been made on this continent is the exaggeration of the ignorance of the Russian people. Illiteracy is not so common as some seem to think. Several years ago the Duma forced the government to adopt a thorough educational system, although the war has naturally interfered with its progress."

GORDON T. JENNINGS, A.M.Can.Soc.C.E., has withdrawn from the firm of Jennings & Ross, Limited, engineering-contractors, and is at present devoting his time to work in connection with the construction of the aviation camps.

J. WHITE, of the ornamental iron department of Canadian Allis-Chalmers, Limited, has been appointed general superintendent of the Canada Foundry Company's Davenport works, in place of J. J. SCOLLAN, who recently resigned.

R. B. FREELAND, who for a number of years has been connected with the Granby Smelting and Mining Company at Grand Forks, B.C., has been appointed district engineer for Mineral Survey District No. 4, with headquarters at Grand Forks.

N. B. DAVIS, B.Sc., until lately assistant engineer in the Ceramic Division, Mines Branch, Ottawa, has opened an office as consulting geologist as applied to engineering, examinations of water, bridge and building sites, at Kingston, Ont.

ALEXANDER FORBES PROCTOR, graduate of Aberdeen University, has been appointed chief engineer of the British Columbia Provincial Department of Railways, vice F. C. Gamble.

WALTER J. FRANCIS, M.Can.Soc.C.E., well-known consulting engineer of Montreal, has been elected president of the Rotary Club, of that city. The election is a tribute to the large amount of time that Mr. Francis has devoted to civic improvements and public affairs in general for many years past.

F. L. FELLOWES, city engineer of Vancouver, B.C., has returned home after having spent considerable time in Ottawa, Montreal and Toronto, during which time he made an exhaustive examination into the harbor questions in the port cities and discussed the Vancouver harbor situation with the Dominion authorities.

D. O. LESPERANCE, chairman of the Quebec Harbor Commission, has been elected president of the General Car and Machinery Works of Montmagny, Limited, Quebec, succeeding CHARLES A. PAQUET, who has resigned as president to take the general managership. Mr. Paquet succeeds W. E. PATTERSON, who has asked to be relieved on account of ill-health.

FRANCIS CLARKE GAMBLE, past-president of the Canadian Society of Civil Engineers and chief engineer of the Department of Railways of British Columbia, is reported to have been abruptly dismissed by Hon. John Oliver, the Minister of Railways in the new British Columbia government. Beyond the announcement of his action, the minister said he had no statement to make, but it is thought that the dismissal was entirely a result of political affairs. H. A. ICKE, engineer in charge of the improvement work in the Songhees Reserve, has also been dismissed. Mr. Gamble has been in the service of the British Columbia government for about twenty years and was chief engineer for the province until 1911, when he was appointed engineer of railways. He was president of the Canadian Society of Civil Engineers in 1915 and is at present an ex-officio member of the council of the society. He is a member of the American Society of Civil Engineers and has taken a prominent part in public affairs in British Columbia. He was the author of a very interesting paper on the development of transportation in British Columbia, read before the Canadian Society of Civil Engineers in January, 1916. Mr. Icke was formerly employed by the city of New Westminster in charge of the construction of Smith's Hill reservoir, and has been employed by the province for the past three years in charge of irrigation and development work.

OBITUARIES.

H. G. MATTHEWS, general manager of the Quebec Railway, Light and Power Company, Quebec, passed away on July 4th. The late Mr. Matthews was born in Montreal on July 1st, 1878. Before becoming associated with the Quebec company, in 1911, he was manager of the Marconi Wireless Telegraph Company of Canada. He was also president of the Lotbiniere and Megantic Railway Company, and a director of the subsidiary companies of Quebec Railway, Light, Heat and Power Company, Limited.