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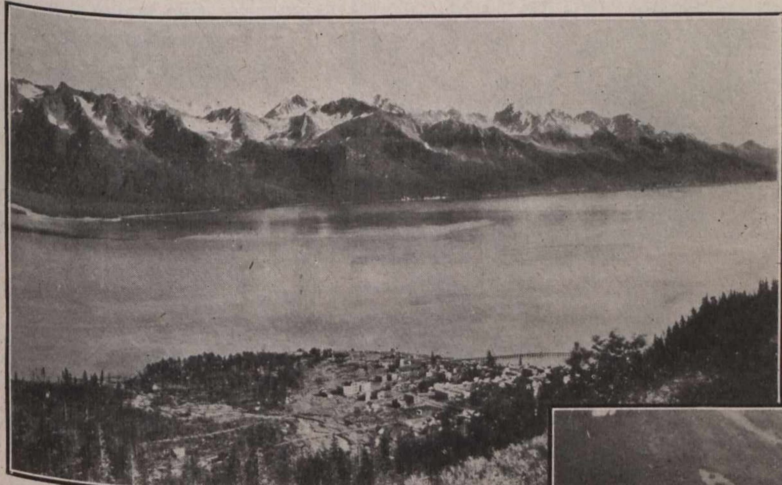
GOVERNMENT RAILWAY OF ALASKA

SOME INTERESTING NOTES ON AN INSPECTION OF THE LOCATION OF THE ALASKA CENTRAL RAILWAY, ABANDONED FOR EIGHT YEARS, BUT CONSTRUCTION NOW RECOMMENCED BY THE U.S. GOVERNMENT.

By W. R. C. MORRIS, M.Inst.C.E.

THE Alaska Central Railway was begun in 1902, but in 1907 the works were stopped on account of want of capital, and have since then been in the hands of the official receiver.

After careful investigation into the best route for opening up the country, the United States government determined this year that the Seward to Fairbanks location was the most satisfactory one to fulfil all conditions, and they have consequently purchased the works, and last June they sent a large staff of engineers and assistants to recommence construction.



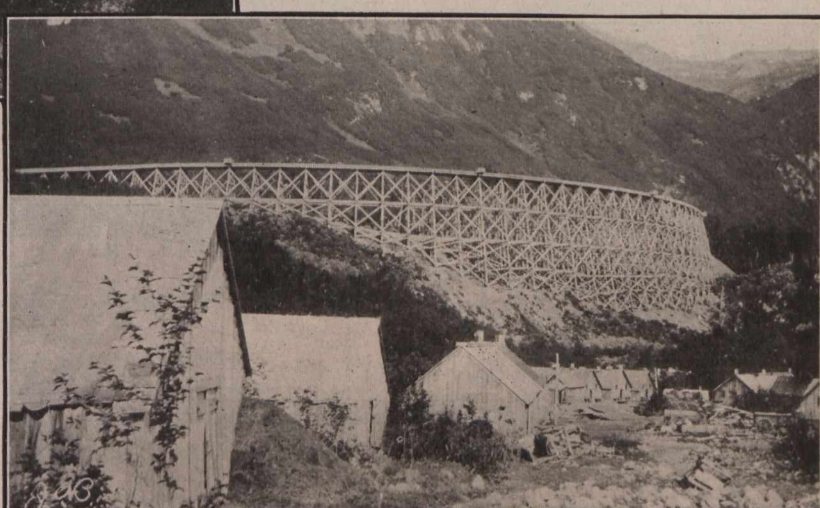
Town of Seward, Resurrection Bay, Southern Terminus of the Central Alaska Railway.

In 1908 it was the writer's good fortune, instructed by Sir Douglas Fox and Partners, of London, England, to visit Alaska, with the object of drawing up a report on the advisability, and cost, of constructing the railway (of which about 60 miles from tidewater were nearly completed), as far as the newly discovered Matanuska coal fields, some 184 miles in all, leaving the main line from Knik Area to Fairbanks for future consideration.

I left Vernon, B.C., in July, 1908, for Seattle, where I joined the rest of the party. We sailed from Seattle on August 8th on S.S. "Pennsylvania" and touching at Nanaimo, Catella and Valdez, arrived at Seward on August 17th.

As mosquitoes were reported to be very bad in the interior, the season was too advanced to attempt the Cook Inlet later in the year, and stories were rife of the difficulties of travel by the usual boats, the delays caused by them, and the length of time they generally took, it was decided to go first to the coal fields, and to inspect the railway route on the return. A gasoline launch, "The Valdez," 12 tons burden with 16-h.p. engines, which had just been built, was chartered and we proceeded along the coast. Though the weather was perfect on leaving Seward, it came on wet and stormy and we did not reach Seldovia in Cook Inlet until August 21st, having kept behind every available island to get protection from the Pacific swell.

At Seldovia we watched with interest the Aleut Indians curing salmon and building canoes. The former cured us of any wish to eat this form of salmon in the future, as the fish being hung up in the open sun for drying purposes were covered with crawling maggots.

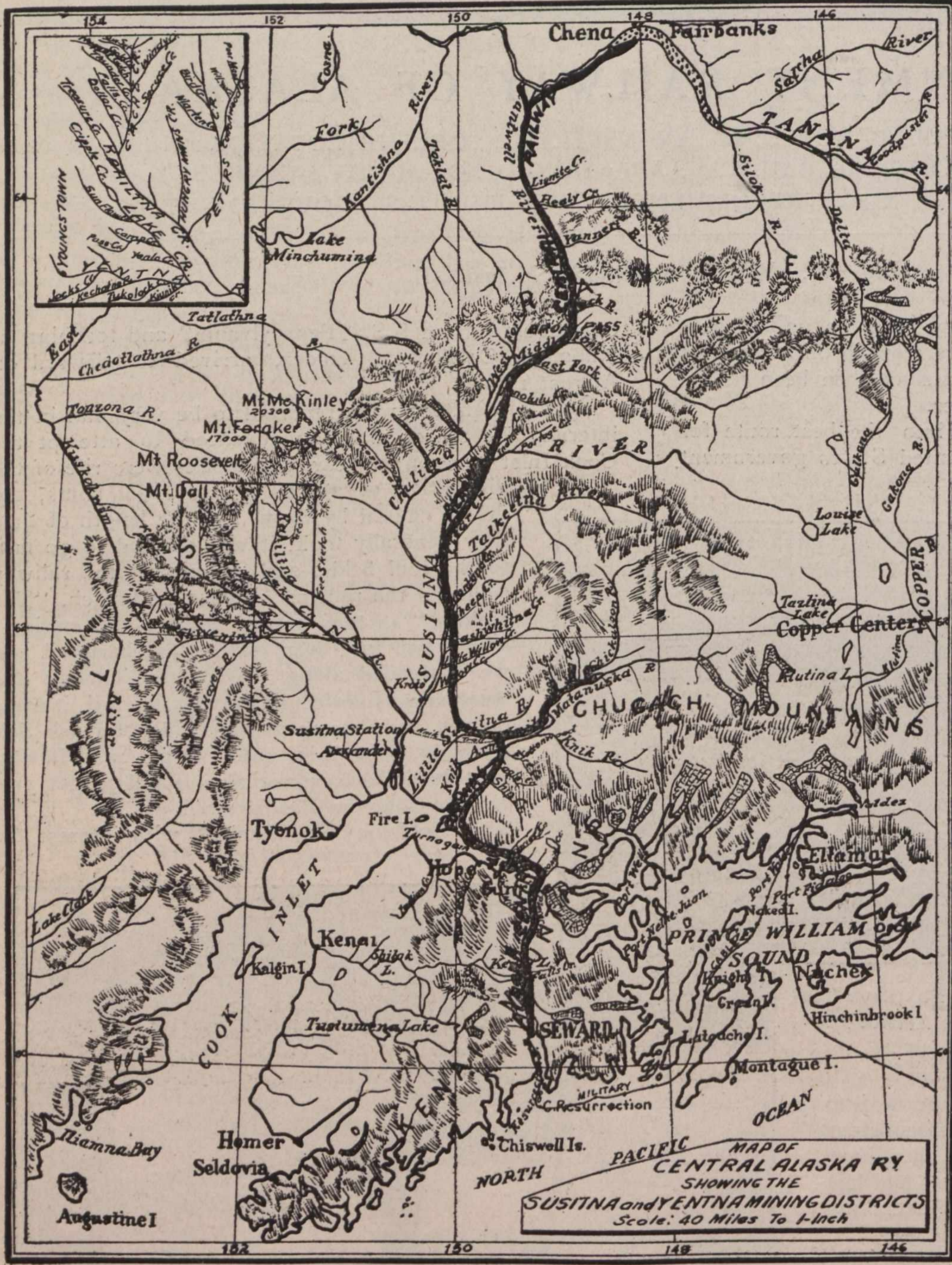


Bridge at Mile 49, Central Alaska Railway, 1,000,000 Feet of Timber in its Construction.

The canoes are made of the skin of the hair seal, which is sewn over a light wooden framework. In spite of their frailty, the Indians venture to sea in them in quite rough weather.

On August 23rd we left Seldovia and faced the fierce racing tide rips of the inlet. The great fish called "white whales," which are found in the inlet, greatly interested us, and though our propeller got caught in the heavy sea-weed, 30 to 40 feet long, which is found all along this coast, we arrived safely at our destination (Knik) by August 24th. At one time our engines refused to work for several hours, and the gale was rapidly drifting us on to a lee shore, but as soon as our skipper lost patience and hoisted the big mainsail, the engines fortunately recovered.

At Knik we obtained horses and started on the pack trail along the proposed route of the Matanuska branch.



The Central Alaska Railway— Seward to Fairbanks, Alaska.

We visited the coal outcrops at Moose Creek, Eska Creek and King's Creek, and arrived at our goal at the Chickaloon Creek outcrop by August 29th. We found that a considerable amount of work had been already done at this outcrop, some 1,600 feet of headings having been driven. The coal is a semi-bituminous one of excellent quality and vast quantity. The government analysis shows a fixed carbon value of 66.08 and a fuel ratio of 3.77. Anthracite, too, has been found further up the Matanuska River.

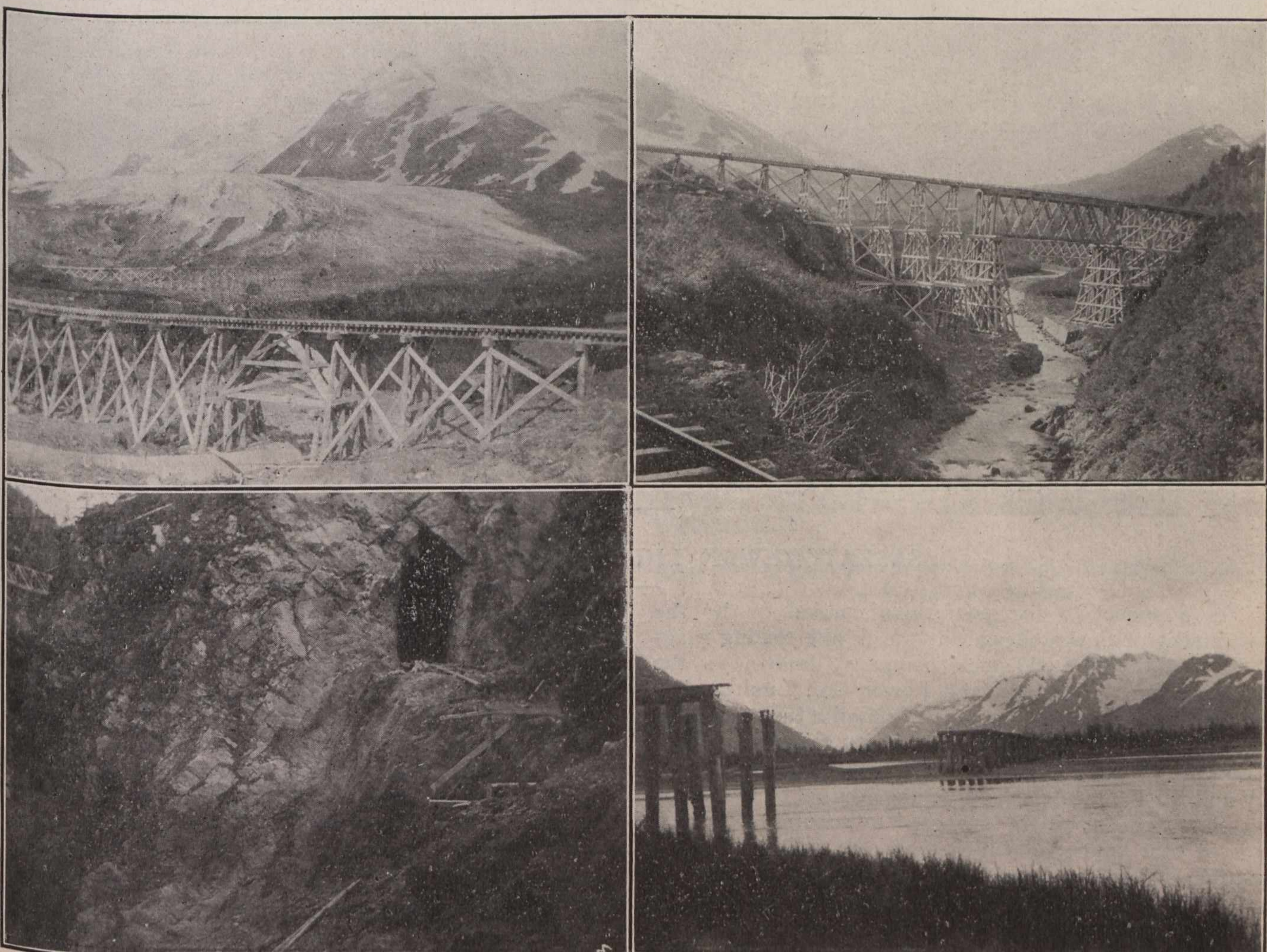
On the trail we found mosquito tents were the only way to obtain a good night's sleep. Trout were most plentiful, and big red salmon (hump-back) were dying in their thousands along the river banks. It was a curious sight to see our retriever dog plunge into a creek and, seizing a particularly lusty one which was trying to work its way upstream over the gravel, hold it up for our inspection.

From Chickaloon we visited Coal Creek outcrop on foot, crossing two wide streams by wire rope and cradle. An unprecedented event for Chickaloon camp took place on August 30th, when a cablegram from London, England, was handed to me, sent by Indian runner along the trail. London to Chickaloon in five days!

On September 4th we again reached Knik, and having engaged a pilot, got on board the launch, with the intention of facing Turnagain Arm, of evil repute. Both Knik Arm and Turnagain Arm are notorious for their dangerous character, the chief points of which are the violent tide rips; the sand banks, which are uncovered at low tide, and become "sinking sand" as the tide rises; and the bore, which runs from 3 to 12 feet in height.

This is the neighborhood where Captain Cook landed in 1778. He wrote in his "Voyages of Discovery": "In the afternoon I sent Mr. King again with two armed boats, with orders to land on the northern point of the lowland, on the southeast side of the river, there to display the flag; to take possession of the country and river in his Majesty's name, and to bury in the ground a bottle containing some pieces of English coin of the year 1772 and a paper, on which was inscribed the names of our ships and the date of our discovery."

Our launch ran aground at midnight on Fire Island, but we floated off again at high tide, and the delay gave us the opportunity of a glorious view of the snow-clad peaks of Mount McKinley (20,300 ft.) and Mount Foraker (17,000 ft.) about 130 miles away to the north, glowing clear and sharp in the early morning sun, which had not reached us. As we approached Sunrise harbor the tide rips caught us and washed some deck packages overboard. It was too dangerous to put about to save them, so they were left to their fate. One, which contained our coal expert's only photographic films, was subsequently recovered from the shore, with the reels little the worse for their immersion.



Bartlett Glacier, Mile 49½.
Wreck of 90-foot Truss by Snowslide, Mile 52.

Trestle Over Placer River, Mile 50.
Twenty Mile River Crossing, Mile 54.

From Turnagain Arm to Chickaloon the railway construction is of a fairly simple character. The grading on the north side of the arm is chiefly rock work, and will be heavy, but on the east side of Knik Arm the rock disappears and the earthwork is light. At the Knik and Matanuska Rivers pile bridges are proposed, 900 and 1,700 feet in length respectively.

The Matanuska Junction is at 146 miles. The heaviest work on the Matanuska branch will be at the Canyon (mile 162) some three miles in length, and 300 to 600 feet in width, where the river sweeps the cliff, as the foot of which the track is located.

At Sunrise three of us with another pilot (the first pilot having shirked the responsibility of again crossing the arm) left the rest of the party, and, reaching the north side of the arm by the launch, worked our way on foot by the unfinished and completed grade from mile 93 to mile 41, where a handcar from Seward met us with mail and food.

The glacial streams were both numerous, deep and swift; between mile 64 and 54 some 25 had to be crossed, but we had on waders and three pairs of Arctic socks each, and got through safely, though we found such footgear heavy for walking on dry land.

By 1908, 52 miles of steel had been laid, standard gauge. It has since been laid to 72 miles and temporarily opened for traffic. This meant that the track work through the Coast Range was completed. Two summits were necessary, one at mile 12 of 703 feet elevation, and the other at mile 45 of 1,063 feet elevation. The heaviest work occurs between mile 47 and mile 54, in which 7 miles the maximum grade of 2.2 compensated had to be employed, as well as the maximum curvature of 14°. A tight loop and a spiral were adopted and 7 tunnels with a total length of 3,441 feet. The trestle bridges built on this 7 miles required 2,650,000 ft. B.M. of timber. At one place the track lay within 400 feet of the huge Bartlett glacier, which is said to be dying.

We found that great damage had been done by snowslides to the works, since the proposed snow-sheds had not been erected before the works were stopped.

At some places great precautions had been taken in the location to avoid the action of snow-slides. Thus at mile 67 a low trestle had been considered preferable, 4,280 feet in length, across the sandy foreshore of Turnagain Arm, which is covered at high tide, rather than run the risk of damage on the solid slopes.

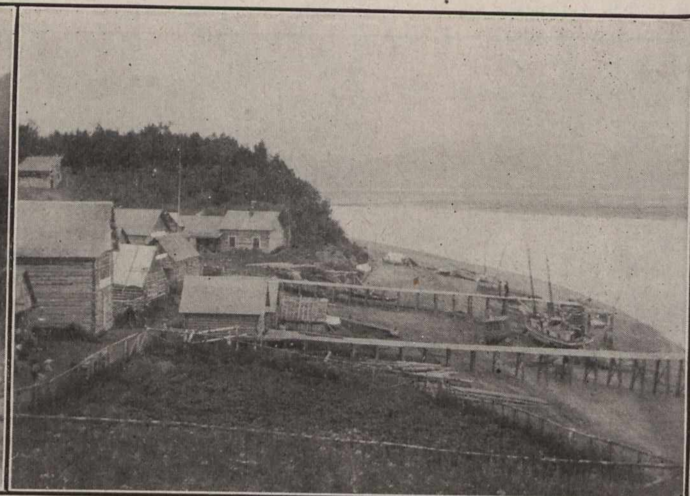
The terminal is at Seward on Resurrection Bay, an excellent harbor, 16 miles in length, and 5 or 6 miles in width, free from ice all the year round, and, having a comparatively narrow entrance with a high island in the centre, it could be easily fortified. The U.S.A. Naval Department had made a reservation of 3,200 acres near Seward for a coaling station.

The railway company have erected a fine head office at a cost of about $39,000.

The land to the southwest of Turnagain Arm forms the Kenai Peninsula, and is already noted for its magnificent hunting and fishing.

The whole route of the railway from Seward to Fairbanks lies through what is officially reported to be a rich mineral country, and agricultural prospects, too, are good, so that the future of the undertaking is practically assured.

Timber Pile Bridge, 6,000 Feet Long, Mile 67.



Knik and Yacht "Valdez" A.C.R.

SASKATCHEWAN LIGNITE DEVELOPMENT.

As a sequel to the operations carried on by the government of Saskatchewan at the lignite testing plant at Estevan, a limited stock company, known as the Saskatchewan Coal, Brick and Power Co., Limited, has recently been formed to manufacture lignite fuel and other products at Shand, Sask., about thirty miles south-east of Estevan on the main line of the C.P.R. between Moose Jaw and St. Paul. According to the Journal of the Canadian Peat Society, it is proposed to acquire about 300 acres of coal lands, on which there are estimated to be upwards of 4,000,000 tons of minable lignite of excellent quality. The principal seam which is now being mined is nine feet thick and eighty feet below the surface. There is at present on the land a plant for mining coal and making wire cut brick, with a capacity of 500 tons of lignite and 50,000 brick per day.

The company proposes to produce: Dried lignite for use with automatic stokers and in fuel gas producers; powdered fuel from the dried pulverized lignite; dried lignite briquettes for use in large hand-fired furnaces; carbonized lignite for use in power gas producers; carbonized lignite briquettes for domestic service; gas, which may be sold as "town gas," utilized for production of cheap electrical power, or for burning clay products; power, derived from the surplus gas generated in the carbonizing process; sulphate of ammonia, of which about 15 lbs. are procured from each ton of lignite; tar products; clay products. At the outset only simple distillation products will be procured, such as fuel oil, creosote and other oils and pitch. Later it is proposed to manufacture various synthetic chemical products. Eventually it is expected a complete line of common, face and ornamental brick, hollow ware, partition, floor and roof tiling, sewer pipe, drain tile, and many kinds of common pottery will be manufactured.

A brochure issued by the company points out that tar products have heretofore come from Germany. The total export of Germany's coal tar industry in 1913 is said to have been $55,264,522, produced by twenty-two factories, whose average dividends were 21.74 per cent. It is estimated that electric power can be generated at very low cost, and that eventually the government of Saskatchewan will undertake the distribution of power over its own transmission lines in the same manner as Niagara water power is now distributed over Ontario by the Hydro-Electric Commission.

The lignite on the company's property is said to be of excellent quality, as shown by analysis:—

Volatile matter	37.5 per cent.
Fixed carbon	54.5 per cent.
Ash	8. per cent.
	100. per cent.

Calorific value of dried lignite, 11,000 B.t.u.
Percentages determined on dry basis.

The southern part of Saskatchewan will furnish billions of tons of lignite. Only about 200,000 tons are now mined annually, while 2,000,000 tons of eastern and western coals are imported at high cost into the territory naturally tributary to this source of supply. When local lignite areas and accompanying clay deposits are developed, millions of dollars which would otherwise be sent out of the province annually for fuel and building materials will be kept at home.

AERATION METHOD OF PURIFYING SLUDGE.

PURIFICATION of sewage by aeration, although not new in a sense, has been a subject of great attention and study of late and the past year or so has brought forth some valuable literature regarding experiments and their application to sewage disposal works. In *The Canadian Engineer* last week we referred editorially to the activated sludge treatment and to the importance to Canadian municipalities of the results now being attained by those who are studying the problem. It is likely that the near future will see more attention given to activated sludge experiments by Canadian sanitary and municipal engineers.

Mr. J. P. Wakeford, M.Inst.C.E., city engineer of Wakefield, Eng., deals in an interesting way with some past experiments, in a paper read before the Institution of Municipal and County Engineers last June. He refers first to the Manchester and Salford investigations of Dr. Gilbert Fowler and Messrs. Ardern, Lockett and Melling, mentioned in these columns last week, and then proceeds to describe the experiments made by himself. His description of the system, and of his experiments is as follows:—

Sludge which has been brought into an activated state by thorough aeration is added to raw sewage and the admixture is kept in a state of agitation by forcing air through it for a certain period. The air supply is then cut off and when the solid matters in suspension are deposited, the supernatant liquor is in such a state of purification that it can be discharged direct to the river.

In a biological filter the period necessary for the filter to become "mature" is that period during which sewage sludge is deposited as a slimy film on the surface of the filter material to act as a nidus for the purifying organisms. During this period the slimy film is being converted into "activated sludge," which is the seat of the purification process.

The new process seeks to dispense with the filter material by converting sewage sludge directly into "activated sludge" by means of forced aeration. It is indeed a speeding-up of the processes which have been known for some time as biological methods of sewage purification, for it has been shown by Ardern and Lockett, and confirmed by the author, that the process is biological in that it cannot be carried out with sterile sewage and sterile sludge.

The experiments at the Wakefield works were first conducted in a forty-gallon cask in which a quantity of humus sludge was placed, together with a quantity of ordinary sewage, and aeration was carried on for a few days. The sludge was allowed to settle for two hours and the effluent was drawn off. The barrel was again filled with crude sewage and aerated for twenty-four hours, the sludge allowed to settle for two hours, and the effluent drawn off. This was repeated four times, retaining the sludge in each case. It was noticed that the time required for each succeeding oxidation gradually diminished until eventually it was possible to obtain a well-clarified effluent in two hours.

The table at the foot of this page gives the results of the analyses of the four fillings.

It will be noticed that when the sludge had become thoroughly activated as in case (*d*), it was possible to completely oxidize the ammonia present after two hours aeration.

On the average, aeration for a period of two hours under the conditions of experiments, was sufficient to obtain a percentage purification as measured by the four hours' oxygen absorption and albuminoid ammonia tests, quite equal to that yielded by chemical precipitation and bacterial filters. The aeration was effected by means of a porous tile diffuser set in a light cast-iron box, an air chamber being formed between the underside of the tile and the floor of the box. This diffuser was placed on the bottom of the barrel to introduce the air in the finest possible state of division. The difference between aeration effected by air admitted in large bubbles and that in a fine state of diffusion is clearly seen in the following table, taken from Part 2 of Messrs. Ardern and Lockett's researches on the "Oxidation of Sewage Without the Aid of Filters" (Journal Society of Chemical Industry, Volume XXXIII.):—

Rate of Oxygenation of Raw Sewage, Results Expressed in Parts per 100,000.

Dilute Sewage.

Time	Dissolved Oxygen Content when Aeration effected by:— Plain Tube	Diffuser
At commencement	.24	.24
After 15 minutes	.42	.73
" 30 "	.49	.74
" 45 "	.56	.76
" 60 "	.57	.77
" 90 "	.63	.79

Messrs. Ardern and Lockett have also proved that temperature influences the oxidation process, the sewage

DESCRIPTION	Oxygen absorbed in 4 hours at Lab Temperature	Percentage Purification on Oxygen Absorbed Figure	Ammonia (as N) Free and Saline	Albuminoid	Nitrites (as N)	Nitrates (as N)
(*a*) Crude sewage, average	9.88	—	3.750	.780	—	—
After 6 hours' aeration	1.86	81.2	.480	.192	Nil	1.20
" 24 " "	1.10	88.9	.060	.156	Nil	1.60
(*b*) Crude sewage	12.48	—	4.250	.800	—	—
After 4 hours' aeration	2.92	76.6	1.800	.328	Nil	.40
" 6 " "	2.64	78.9	1.200	.248	Nil	.86
" 12 " "	2.08	83.3	.300	.180	Nil	1.40
(*c*) Crude sewage	13.96	—	3.500	.750	—	—
After 2 hours' aeration	1.47	89.5	.700	.132	—	.50
" 4 " "	1.28	90.8	Nil	.080	—	.90
(*d*) Crude sewage	16.44	—	2.750	1.140	—	—
After 1 hour's aeration	1.57	90.5	.100	.096	.10	.50
" 2 hours' "	1.22	92.6	Nil	.076	Trace	.90
" 3 " "	.94	94.3	—	—	—	—

being clarified much more rapidly in the summer months than in the winter months. This can doubtless be overcome by using warm air when the temperature of the sewage is below normal.

In another series of experiments, samples of humus sludge contained in 80-oz. bottles were aerated for ten days, when the sludge had become thoroughly "activated." At the end of this time a sample of Wakefield raw sewage was aerated in contact with the "activated sludge," samples being taken every hour over a period of six hours. These results are shown in the following table:—

Experiments Carried Out in 80-Oz. Bottles.

Results Expressed in Parts per 100,000.

	4 Hours' Oxygen Absorption	Free and Saline Ammonia (as N.)	Albuminoid Ammonia (N.)	Nitrites and Nitrates (N.)
Crude sewage	8.44	4.429	1.371	.257
After 1 hour's aeration	1.73	2.071	.543	.557
" 2 hours' "	1.34	1.786	.400	.772
" 3 " "	1.18	1.600	.371	.800
" 4 " "	1.10	1.428	.314	.858
" 5 " "	1.02	1.214	.257	.858
" 6 " "	0.86	1.071	.200	1.000

NOTE.—The air being admitted by glass tubing, the results were not so satisfactory as those obtained where the air was diffused.

Following the results of the experiments in the barrel it was next decided to test the process on a much larger scale and a tank 30′ 0″ by 12′ 0″ by 6′ 6″, has been installed giving a capacity of about 11,000 gallons, exclusive of the "activated sludge." At the bottom of the tank ten sets of diffusers are fixed, four in each set, all connected to the main air delivery pipe. The air is forced through by means of an air compressor, consuming 90 cubic feet of air per minute, at a pressure of 5 lbs. per square inch.

A quantity of humus sludge, about 25 per cent. of the total tank capacity, was placed in this tank which was afterwards filled up with a weak night sewage. After aerating for a few days the results obtained were not satisfactory. Samples were taken at different depths, when it was ascertained that the sample from the bottom contained a great deal more sludge than the sample at the top of the tank.

Since the main object to be aimed at is the intimate contact of air and sewage in the presence of "activated sludge"—air to be in solution as much as possible—the arrangement in the tank is obviously wrong. The area of the tank is 360 square feet and the area of the diffusers is 40 square feet, therefore the surface of the bottom of the tank through which the air is admitted is only about 11 per cent. of the total floor area. The small bulk of sewage immediately above the diffusers is in rapid movement upwards, whilst 89 per cent., or the remainder of the tank, depends upon its supply of air and activated sludge by the falling backwards of the particles and by cross-currents. It was found that the "activated sludge" which should during blowing operations, have been in complete suspension and agitation, had deposited in banks on the spaces between the sets of diffusers. To obviate this difficulty the space between the diffusers was banked up in concrete in ridges about 18″ high and by this means every particle of sludge was kept in motion and any solids falling on the ridges were carried by the water above on to the diffusers and forced up again by the air. This method proved satisfactory, the sludge becoming "activated" very rapidly. At the surface immediately over the diffusers there is, however, violent agitation, which does not occur between the diffusers, and the formation of large air bubbles would seem to indicate that this method of applying the air is not uniform and that it will be necessary if the air is to be introduced at the bottom that the floor of the tank should be completely covered with diffusers, and if constructed of the present type on a large scale would be extremely costly. On the other hand the cross ridge and pocket formation would be most difficult to empty and cleanse. Whilst the aeration was proceeding it was apparent that the porosity of the tiles was very uneven and the tiles unsuited for the purpose, and that the ideal false floor which must be economical in cost and easily cleaned has yet to be evolved.

Since it appears that such a floor is imperative to the process an observation shaft 12 ins. square has been constructed for the purpose of experimenting with various materials and tiles. The shaft is so designed that it will be possible to observe the diffusion of the air and by means of taps placed in the side to take samples at depths varying from 1 ft. to 8½ ft.

The aerating tank is worked on the "fill and draw" principle, taking about ½ hour to fill, 2 hours blowing, 2 hours settlement, ½ hour to empty, making a five hours cycle.

In this tank the air is used for both oxidizing and agitating the sewage simultaneously, but it might prove of considerable advantage if the circulation of the sludge could be obtained by mechanical apparatus, using the air for oxidation only, thereby effecting a considerable saving in air consumption.

Whether the "fill and draw" method will eventually prove to be the simplest to work and give the best results, or whether a properly designed continuous flow treatment will be the more effectual remains for further investigation. If the engineering difficulties in the way of carrying out the process can be overcome it should be possible to purify sewage in tanks having a capacity of five or six hours' flow of sewage. At the present time tanks are constructed larger than this merely for the settlement or precipitation of the suspended matter from the sewage, but in the new process the suspended matter in the sewage is so altered in character that it settles very readily.

The "activated sludge" is quite inoffensive, dark brown in color, flocculent in character and separates rapidly and completely despite its low specific gravity, is inodorous and readily drained.

The chemical analyses of an average sample of the "activated sludge" and precipitation sludge are compared in the following table:—

Analysis of an Average Sample of Dried

	Precipitation sludge Percentage	Activated sludge Percentage
Organic matter	56.14	43.99
Mineral matter	43.86	56.01
Nitrogen, free and saline	—	.052
Total nitrogen (Kjeldahl)	1.30	4.59
Iron (Fe_2O_3)	4.34	9.67
Phosphate (P_2O_5)	0.95	2.74

The moisture in the precipitation sludge is 91.1 per cent. and in the "activated sludge" 96.73 per cent.

None of the forms of sludge generally produced are of much value as manure, but attention should be drawn to the abnormally high percentage of nitrogen in "activated sludge" as compared with ordinary unoxidized sludge.

Since the sludge in a dry state contains 4.59 per cent. of nitrogen it should become a saleable product of high manurial value, and if not a source of revenue should at least cease to be the drag and bugbear at all sewage disposal works.

The purification of sewage by forced aeration has been demonstrated as a scientific fact by Dr. Fowler, who is admittedly on correct lines, and the object of presenting these notes is not to prove the principle of forced aeration or to make pretensions of having solved any of the difficulties, but to arouse the interest of engineers so that by concerted action we may translate Dr. Fowler's experiments to a working scale of an extensive character.

Up to the present the matter has been dealt with almost exclusively by the chemists, but the small open tank and the few experiments conducted therein at Wakefield have proved that the engineering difficulties to be faced are numerous. These can doubtless be overcome by experimental work, but more money is required for such purpose than the author has at present at his command.

One of the greatest possibilities of the process lies in the fact that it may be feasible to effect in tanks a much higher percentage purification than has hitherto been accomplished, so that the effluent might be applied to existing filters at a high rate and thus avoid extension of filter area.

If sufficient energy and money were expended on this aeration principle there is ample justification for assuming that disposal works could be designed which would possess the following advantages:—

(1) Since the rate of purification would be accelerated, sanitary conditions would be improved.

(2) The residual sludge, owing to the ease with which it could be handled and its high nitrogen content, would be more readily converted into a valuable fertilizing agent.

(3) Putrefaction would be less likely to occur, thus avoiding offensive smells, and if percolating filters could be dispensed with, fly troubles would cease.

(4) A very high percentage of purification could be obtained yielding an effluent which would be non-putrefactive on incubation.

(5) Smaller outfall works would suffice, thus effecting a reduction in the area of land required.

(6) Reduction in capital costs for the following reasons: (*a*) Purification would be accomplished by single tank treatment, obviating the necessity for bacterial filters; tank capacity would be less than that required for preliminary treatment in either septic or sedimentation tanks. (*b*) Owing to the improved sanitary conditions, the absence of smell, and the reduction in area of land required, the sites of works might be much nearer towns and on areas which under present methods would be impossible, or open to grave objections. The length of outfall sewers would consequently be curtailed.

(7) Reduction in maintenance costs for the following reasons: (*a*) Chemicals would be unnecessary with a corresponding reduction in the bulk of sludge to be manipulated. (*b*) The sludge being of higher manurial value for agricultural purposes, doubtless the revenue derived from its sale would at least meet the cost of its removal. (*c*) Works being smaller and more compact, the expenditure on supervision and attendance would be reduced.

The most important uses of coke are in metallurgical operations, such as the smelting of iron in blast furnaces; the remelting of iron in the iron foundry; and the smelting of copper, lead, nickel, silver, etc. Oven coke is always used for these purposes, as a strong, hard coke is required. For blast furnaces, great compressive strength is essential; but for copper smelters, porosity is important.

DEEP BORING IN CANADA INVESTIGATED BY THE GEOLOGICAL SURVEY.

For several years the Geological Survey of the Department of Mines, Ottawa, has been collecting and recording information regarding deep well borings throughout Canada. As a rule, the Survey acquires first knowledge of drilling operations through the newspapers or similar sources of information, and preliminary data respecting each instance is then obtained by the establishment of correspondence relations. The characteristics of and variations in the strata penetrated are ascertained most generally from samples illustrative of every few feet of boring. The results of the work of this division of the Survey, apart from the accumulation of records and samples will be made available to the public through reports, bulletins, etc., and there is no doubt that much benefit will be derived from them. The Commission of Conservation has already referred to the great need for collecting information on borings.

This work was begun by the Geological Survey in 1885. In 1891 a report was issued giving particulars of all borings which were available in Ontario prior to 1891. This report gave plans of the different gas and oil fields of the province together with cross-sections of the strata as worked out from these data. Important sets of samples of drillings were then collected and are now filed in the present Borings Division. Supplementary information of this nature was published in the annual reports. In the year 1898 maps showing the limits and distribution of the various gas and oil fields of Ontario were published from data resulting from field studies. A similar report for the use of those interested in borings in the north-west provinces was published in 1913 and includes all available boring records for the above region up to the date of issue.

The increasing activities in boring in recent years and its expansion over the whole of Canada called for special provision for the carrying out of the work and in the inauguration of the Department of Mines, the Act provides that it shall be a function of the Geological Survey Division: "To study and report upon the facts relating to water supply for irrigation and for domestic purposes, and to collect and preserve all available records of artesian or other wells." It thus falls to the lot of the Borings division to study all sources of information relating to these matters so as to collect all data bearing on the problems involved and by consultation with other members of the Survey staff, having special local knowledge, to interpret the information thus collected in the interests of the operators.

Outside the efforts made by the Geological Survey a certain amount of attention has been paid to this subject by the officials of the provincial governments. The annual reports of the Novo Scotia government give details of the operations of their own drills. These are mostly core drills and are used at different points in the province in the search for seams of coal and for iron and other mineral deposits. In the other eastern provinces no systematic work has been done either in boring or in collecting records. The provincial government of Ontario has never operated drills, but the officials of the Bureau of Mines have published from time to time very complete studies of the gas and oil fields of the province with logs of borings and all information necessary to an understanding of the mode of occurrences of these minerals. In the north-west the official reports issued under the territorial governments contained particulars of the operation of drilling rigs, a few of which were owned by the government. Numerous auger drills were similarly owned and loaned to the various municipalities and to others using them for shallow wells in search of water. This policy was discontinued, however, shortly after the inauguration of provincial governments.

The attempt to acquire the valuable geological and economic data obtained as a result of the hundreds of borings made in Canada in any one year is found in practice to be beset by many serious difficulties. The particulars must be obtained at second hand through the mechanics operating the drills, and it is difficult in most cases to enlist and maintain their sympathetic co-operation. Then, too, it is seldom that the operator will have such a knowledge of geology that he will see the importance of the details the geologist finds it necessary to observe if any useful results are to be gained. It is further found difficult to impress operators with the necessity for sending complete tests of samples taken at close enough intervals in the drilling.

An added difficulty arises from the finely pulverized character of the rock material sent in, which results from operations of the churn drill, the apparatus most generally used, since in such samples there is little chance of getting fossils. Larger fragments are sometimes obtainable in this method of boring, but it has been found very difficult to impress upon the working driller the need for preserving and transmitting these. It is important, also, that drillers should send unwashed samples and that the logs of wells should be accompanied by corroborative sets of samples.

In New Brunswick, a large number of new drillings were added during 1914 in the Moncton gas and oil field. In boring operations the chief activity seems to have been in connection with cleaning out and deepening operations. The gas from the Moncton field is utilized in the towns of Moncton and Hillsborough.

Deep boring in Quebec has been practically limited to the operations of two companies in the St. Barnabé district of St. Hyacinthe county. This is situated a short distance northwest from the town of St. Hyacinthe. In the year 1910 a deep boring was put down to a depth of 1,880 feet by local capitalists in the search for natural gas or oil and a flow of gas was struck at 1,860 feet which still persists. This find was reported upon by Mr. Theo. Denis in his report of 1910 to the Quebec Government. The present operations are undertaken with the purpose of further testing this field. The position of the anticlinals and synclinals and other factors of this region can only be ascertained in a very general way from surface geological studies as the rock exposures are so few and scattered. For this reason boring for some time will be experimental in character.

Mr. Robert Harvie, of the Survey staff, made an examination of the country in the vicinity of the borings in conjunction with Mr. Theo. Denis, Superintendent of Mines of the Quebec Government, and, as a result, further light was thrown on the problems involved in the experiment. When the policy of putting down a number of comparatively short holes, as suggested to the operators, has been carried out, deeper borings placed more definitely along the crests of the anticlinals thus located, will show more effectively whether larger pools of gas exist than those partially proved by the boring ventures so far completed.

In Ontario deep borings are naturally most actively carried on in the southern portions where the surface deposits are underlain by the sedimentary series of Palæozoic formations. These divide naturally into two main areas: that west of the Archæan axis which crosses the St. Lawrence River between Brockville and Kingston, constituting the Thousand Islands, and the other east of this divide.

In the eastern area of Palæozoic rocks, occupying the wedge between the Ottawa and the St. Lawrence rivers, sporadic boring has been done in the past and a number of deep wells have been put down. Some of these reached almost to the underlying Archæan and in one case penetrated it for a few feet.

In Ottawa city a number of these wells have been put down to obtain water and in several instances a little natural gas was encountered. In the case of the deep bores put down at different points in the territory east of Ottawa, the object was the search for the gas or oil; but while neither was obtained in commercial quantities both were found to be of widespread occurrence. Considering the extent of the territory, the comparatively few borings, and the conditions under which some of them were prosecuted, the question of the occurrence of pools of gas or oil in portions of the region where the general geological conditions are fairly favorable, would seem to be still an open one. During 1914 no further ventures were made in this field.

West of the Archæan divide, already mentioned, the sedimentary strata underlie the whole of the peninsula of Ontario bounded by Georgian Bay, Lake Huron, and Lakes Erie and Ontario. A line drawn from the southeast angle of Georgian Bay to the vicinity of Kingston constitutes the easterly limit of this area, the underlying rocks of the Archæan complex rising from beneath the sedimentary formations constituting all the country to the east and north.

The lower Palæozoic strata, the limestones of Black River and Trenton age, outcrop from beneath the covering strata over a broad belt of country between the above mentioned eastern boundary and the line extending southeasterly from Collingwood on Georgian Bay to the shore of Ontario. Along this belt of country numerous borings were made during 1914 in search for water and small quantities of natural gas have been reported from isolated points, as in past years. Considering the lack of impervious covering strata, it is not to be expected that any lasting sources of natural gas or oil will be encountered in this area.

Westward, where the Trenton group lies beneath the shaly series of Utica, Hudson River, and Median age, in two deep borings for water in the vicinity of Toronto flows of gas were said to have been encountered which would seem to be equal in importance to the limited flows reported from borings in previous years from this district from horizons in the Hudson River and the lower part of the Trenton. A similar occurrence was reported from a depth of 1,600 feet at Milton in Halton county. No logs are at present available from any of these wells, but from the depths reported the showing of gas might come from the bottom of the Utica or upper part of the Trenton.

North of this a development of great interest is reported in the finding of gas in considerable quantity in a boring made in Puslinch township, Wellington county. Here the surface rocks are limestones of Guelph age and the gas is reported as coming from a depth of about 2,000 feet. At this depth the bore would probably be in the upper part of the Trenton. According to reports, the flow and pressure were such as would differentiate this find from the small pockets of no lasting value apt to be encountered in deep borings in any part of the Palæozoic series. Northwesterly along the outcrop of the same strata of Guelph age boring was done about thirteen years ago and encouraging flows of natural gas were obtained in Amabel township, Bruce county. It is reported that further search for gas by boring is likely.

In the older and well recognized natural gas districts of Welland, Kent, and Essex counties, reports show that boring has been undertaken at a number of points in the search for further supplies of gas. No definite particulars as to results have been obtainable. Near Amherstburg and Ojibway in Essex county, adjacent to the Detroit River, borings were made to test the underlying salt beds.

The most interesting development in western Ontario is that of the deep boring in the Oil Springs district of Lambton county. This district was for years one of the older and well recognized oil producers. The oil was obtained from the Corniferous at the comparatively shallow depth of 400 to 500 feet. Recent deep borings resulted in heavy flows of gas at a depth of about 1,900 feet, which would bring the bottom of the boring into the lower part of the Onondaga. The initial discovery in the spring resulted in a great rush to the district and in the prosecution of numerous boring enterprises not only in the immediate vicinity of the original gusher but throughout the adjacent parts of Lambton county. Later a number of the holes having proved "dry" and the pressure and volume of gas having rapidly dropped away, the excitement subsided.

Deep borings for water supply have been put down at a number of points, notably at St. Thomas and at Guelph. At Sault Ste. Marie, Ontario, a similar undertaking seems to have resulted in no great supply.

During 1914 very little information has been obtained from Manitoba and only a few samples were sent in from shallow wells bored for water. Tests were made at Manitou and at Gilbert Plains for oil and gas with some flow reported in both cases.

In Saskatchewan, there are deep wells at: Moose Jaw, two wells over 3,100 feet; Maple Creek, 2,100 feet; near Edgeley, 2,425 feet; Canora, 900 feet. There are others at Viscount, Waldeck, Lehman, Keithville, Wilkie, Vanda, Baldworth, Nokomis, and Sovereign. Prospecting for oil and gas was carried on at Lancer, Hanley, Estevan, the Dirt Hills, and at Battleford, and near Dundurn, in a well bored for water, traces of oil were reported at 210 feet.

In Alberta, owing to the greatly increased activity in 1914 in the Calgary field, drillings were received by the Survey from important centres all over this province. These have all been carefully sorted and filed, and sets from special localities have been set out and examined in order to supply information to the many inquiries from prospectors in new districts.

Besides the Calgary district, information is on file relating to boring operations at Lethbridge, Macleod, Waterton Lake (1,753 feet), Pincher Creek (300 feet), Sweet Grass (1,250 feet), Taber (2,350 feet), Bow Island (1,870 feet), Brooks (2,795 feet), Coutts, Mud Lake, Black Springs Ridge, Keho Lake, Blood Reserve, Landbreck, Calgary (3,414 feet), Gleichen (106 and 100 feet), Aldersyde (1,390 and 1,500 feet), Wetaskiwin, Red Deer, Lacombe, Wainwright, Cochrane, Moose Mountain, Jumping Pound, Mitford, Medicine Hat, (893 and 600 feet), Cardston, Steveville, Redcliff, Carlstadt, Edmonton, Nakamum, Viking, Vegreville, Morinville, Irma, Athabaska Landing, Fort McMurray, Pelican, Moose Portage.

Nearly all the wells reported were drilled for gas and oil, a very small percentage being for water and in search of coal seams.

Regarding the Calgary district activities the following extracts from a report by Mr. S. E. Slepper illustrates their extent.

The MacDougall Segur Oil Co. was the first to begin drilling operations. They "spudded in" in January, 1913. Soon afterward well No. 1 of the Calgary Petroleum products Co. was started. On October 6, 1913, at a depth of 1,556 feet this company penetrated an oil bearing sandstone and a small quantity of a very light oil was obtained. This oil was cased off and drilling continued. Besides the oil, several gas horizons were passed through. After this discovery other companies which had already been formed began drilling. The Black Diamond No. 1, Southern Alberta, Federal, Western Pacific, and United No. 1, were all drilling in the spring of 1914. On May 14, the Calgary Petroleum Products Company's well No. 1 encountered a second oil-bearing stratum at a depth of 2,718 feet. The second strike brought many other companies into the field and drilling became general over the greater part of the foothills region of Southern Alberta. There were 44 drilling outfits which began to operate, but a number of these soon ceased work.

Cable tools, with the California type of standard rig, are in general use in the field. Diamond drills and a rotary type using a "fish tail" bit or revolving steel disc cutters are also being operated. A pole-tool outfit was used by one of the companies for a time. Drilling is slow and difficult because most of the wells are boring through strata that are highly inclined and of varying hardness. Hence, crooked and badly caving holes are a continual source of trouble.

In British Columbia the diamond drill is freely used, as in mineral districts elsewhere, in testing ore deposits; but all such operations are of purely local importance and do not yield any data of general geological significance.

Some excitement existed during 1914 with regard to the district around Revelstoke based on the belief that gas or oil might be obtained there by deep boring. From the geological data available it would not appear that the conditions are favorable to such assumptions.

Deep boring has been prosecuted in the estuary of the Fraser River at Pitt Meadows where the sedimentary deposits with a considerable thickness of arkose at the base lie on the granitic rocks of the coast batholith. A few samples of drillings were received for determination. As the arkose represents the broken up material of the adjacent igneous series it is difficult to distinguish one from the other in the pulverized samples resulting from the operations of the churn drill.

These notes on Canadian drilling and boring operations are from the report of Mr. E. D. Ingall, of the Water and Borings Division, Geological Survey.

SCOTIA WILL SHIP CARS.

The Nova Scotia Steel and Coal Company will commence shipping the 2,000 cars which the company are now manufacturing for the Russian government early in August. Arrangements for the transport of the cars to Vladivostok have been arranged.

The iron and steel plants of the company at Sydney and New Glasgow are running at capacity. President Cantley has stated that the payroll at the present time is the largest in the history of the company, $59,000 having been paid out in wages during the last fortnight, which is at the rate of $4,000 per day.

When the Russian government's order is completed, the manufacture of 1,000 cars for France will be started; negotiations for further war orders are under way.

CANADIAN SMELTING PLANTS FOR IRON AND STEEL.

The Mines Branch, Department of Mines, has recently issued a very comprehensive list of metal mines and smelters in Canada. The following data, extracted from it, relate to smelters, blast furnaces, electric furnace plants, steel furnaces and rolling mills:—

Iron Blast Furnaces.

Company.	Address.	Location of Plant.	Number of Furnaces.	Rated Capacity.
The Dominion Iron and Steel Company	Montreal, Que.	Sydney, C.B.	Six completed	1,680 tons per day.
The Nova Scotia Steel and Coal Co., Ltd.	New Glasgow, N.S.	Sydney Mines, C.B.	One "	250 " " "
Londonderry Iron and Mining Co., Ltd.	Montreal, Que.	Londonderry, N.S.	One "	100 " " "
Canada Iron Corporation, Ltd.	" "	Drummondville, Que.	Two "	15 " " "
" " " "	" "	Radnor Forges, Que.	One "	25 " " "
" " " "	" "	Midland, Ont.	Two "	375 " " "
Standard Iron Company of Canada, Ltd.	Deseronto, Ont.	Deseronto, Ont.	One "	112 " " "
" " " " " " "	" "	Parry Sound, Ont.		84 " " "
The Steel Company of Canada, Ltd.	Hamilton, Ont.	Hamilton, Ont.	Two "	500 " " "
The Canadian Furnace Co.	Port Colborne	Port Colborne, Ont.	One "	300 " " "
The Algoma Steel Corporation	Sault Ste. Marie. Ont.	Steelton, Ont.	Three "	950 " " "
The Atikokan Iron Company, Ltd.	Port Arthur, Ont.	Port Arthur, Ont.	One "	100 " " "

Electric Furnace Plants.

For ferro-products, or steel.

Company.	Address.	Location of Plant.	Products.
The Electric Reduction Company	Buckingham, Que.	Buckingham, Que.	Ferro-phosphorus
Electro-Metals, Ltd.	Welland, Ont.	Welland, Ont.	Ferro-silicon
Electric Steel and Metals Co., Ltd.	" "	" "	Steel castings
Algoma Steel Corporation	Sault Ste. Marie, Ont.	Sault Ste. Marie, Ont.	Ferro-silicon
The Moffat Irving Steel Works, Ltd.	Toronto, Ont.	Toronto, Ont.	Steel castings
Tivani Electric Steel Co., Ltd.	Belleville, Ont.	Belleville, Ont.	" "

Steel Furnaces and Rolling Mills.

Company.	Address.	Location of Plant.	Products.
The Dominion Iron and Steel Company	Montreal, Que.	Sydney, C.B., N.S.	Castings, ingots, billets, rails, wire rods, bars and rods, nails and spikes, wire.
The Nova Scotia Steel and Coal Co., Ltd.	New Glasgow, N.S.	Sydney Mines, C.B. "	Ingots, billets, plates and sheets, bars and rods, rail joints, forged products.
" " " " " " " "	" " "	Trenton, "	
Londonderry Iron and Mining Co., Ltd.	Montreal, Que.	Londonderry, "	
Canadian Car & Foundry Co., Ltd.	Amherst, N.S.	Amherst, "	Bars and rods.
The Portland Rolling Mills, Ltd.	St. Johns, N.B.	St. Johns, N.B.	Bars.
Canadian Steel Foundries, Ltd.	Montreal, Que., B. 1630	Longue Pointe, Quebec	Castings.
" " " "	" "	Pt. St. Charles, "	
The Steel Company of Canada, Ltd.	Hamilton, Ont.	Montreal, Notre Dame St. W., "	Billets, plates, bars and rods, nails, wire.
" " " " " "	" "	Montreal, St. Patrick St., "	Plates and sheets, bars and rods, spikes.
Beauchemin & Fils, Ltée	Sorel, Que.	Sorel, "	Castings.
Joliette Steel & Iron Foundry, Ltd.	Joliette, Que.	Joliette, "	
Canadian Rolling Mills Co., Ltd.	Montreal, Que.	Montreal, "	Bar-iron and steel.
Hull Iron & Steel Foundries, Ltd.	Hull, Que.	Hull, "	Castings.
Grand Trunk Rolling Mills	Montreal, Que.	Montreal, "	
Armstrong, Whitworth of Canada, Ltd.	" " 22 Victoria Sq.	Longueil, "	Ingots, high speed and crucible steel.
Peck Rolling Mills, Ltd.	Montreal, Que.	St. Paul, "	
Dominion Steel Foundry Co.	Hamilton, Ont., Depew St.	Hamilton Ontario	Castings.
The Steel Company of Canada, Ltd.	Hamilton, Ont.	" "	Castings, ingots, billets, blooms, wire rods, rods and bars, spikes.
" " " " " "	" "	Belleville, "	Bars and rods, spikes.
Burlington Steel Co. Ltd.	" " Sherman Ave. N.	Hamilton, "	Bars and rods.
Superior Rolling Mills Co., Ltd.	Fort William, Ont.	Fort William, "	
The Moffat Irving Steel Works, Ltd.	Toronto, Ont., 400 Front St.	Toronto, "	Castings (electric).
Castings of Ottawa, Ltd.	Ottawa, Ont., 203 Bridge St.	Ottawa, "	
The William Kennedy & Sons, Ltd.	Owen Sound, Ont.	Owen Sound, "	Castings.
Provincial Steel Co.	Cobourg, Ont.	Cobourg, "	
Canadian Steel Foundries, Ltd.	Welland, Ont.	Welland, "	Castings.
Electric Steel & Metals Co., Ltd.	" "	" "	
Algoma Steel Corporation	Sault Ste. Marie, Ont.	Sault Ste. Marie, "	Ingots, billets, blooms, rails, rail fastenings.
Swedish Crucible Steel Co. of Canada, Ltd.	Windsor, Ont.	Windsor, "	Castings.
Manitoba Rolling Mills Co., Ltd.	Winnipeg, Man., Box 2994	Winnipeg, Manitoba	
Alberta Rolling Mills Co.	Medicine Hat, Alberta	Medicine Hat, Alberta	Muckbars.
The Redcliff Rolling Mills & Bolts Co.	Redcliff, Alberta	Redcliff,	

In addition, the report lists the copper, nickel-copper, and lead smelters, the aluminum and silver-cobalt-nickel reduction works, and the Cobalt district customs concentrators.

MONTREAL WATER AND POWER EXTENSIONS

PROCEDURE WITHOUT FURTHER ENGINEERING INVESTIGATION CRITICIZED—NOTES FROM OPEN LETTER OUTLINES SITUATION—CANADIAN SOCIETY OF CIVIL ENGINEERS TAKES OFFICIAL INTEREST.

IN Montreal there is now under consideration an expenditure of about $3,500,000 on waterworks improvements. The following are the chief items involved in the project: $1,500,000 for installing hydraulic plant, pumps, etc.; $675,000 for strengthening retaining-walls; $560,000 for bridges over the open viaduct; $475,000 for additional improvements at the entrance of the viaduct; $100,000 for gates; $87,864 for engineering supervision; $35,000 for fences; $25,000 for ditches; $15,000 for culverts; and $25,000 for a wall at Bond Street. The figures do not include the estimate of $900,000 (referred to in *The Canadian Engineer* for July 8, 1915), for a 50,000,000-gallon extension to the filtration plant that is not yet completed. The expenditure up to the present time on the waterworks system is about $5,100,000, and the further proposals would increase the amount to about nine-and-a-half millions.

It is a matter of common knowledge that Canadian engineers, fully competent through training and experience, to pass opinion on the Montreal water supply problem are thoroughly disgusted with the city's methods of handling the undertaking. Matters have been sliding from bad to worse. It is not surprising, therefore, to learn that the Canadian Society of Civil Engineers, through its secretary, Prof. C. H. McLeod, has written the civic authorities, asking that an independent board of engineers be appointed to study the whole proposition prior to further expenditures as listed above. Hope for a satisfactory solution of the already muddled problem, in which a considerable amount of engineering has become unmistakably associated with public knowledge of wasteful and expensive methods, not immune, as the aqueduct break of 19 months ago shows, from danger and distress to citizens, no doubt prompted the Council of the Society to take this action. In sound engineering investigation and advice appear to be the only hope at the present moment for even a specious patching up of an eminently uneconomical and blundering job. But even a report of this nature must, as other reports have done, await the pleasure of the civic authorities, in whose hands the undertaking has attained its present regrettable condition.

Numerous references have appeared in these columns from time to time regarding the design and progress of construction of various portions of recent waterworks projects in Montreal. They are concisely summed up, and the situation clearly outlined, in an open letter written to one of the city controllers by Mr. J. A. Jamieson, a prominent consulting engineer of Montreal, and a member of a board of experts that investigated the water supply conduit break early in 1914. This letter, which repeats the recommendation of that board that the entire aqueduct scheme should be investigated by a commission of independent engineers before further work is done, deals in particular with the city's wild proposal to establish a municipal hydro-electric power plant in connection with the aqueduct enlargement. It reads, in part: I note that the Board of Control have recently submitted to the city council a report recommending that a further amount of $3,610,000, of which $675,000 is for adding extra strength to the retaining-walls, be appropriated for the construction of the aqueduct, or canal, which the city now has under construction for the purpose of developing power for pumping the city's water supply, electric lighting, etc.

The fact of the unsafe design of these walls and the greatly increased cost of walls of safe design was clearly pointed out in "Report to Board of Commissioners on Water Supply Conduit,"* by J. A. Jamieson, R. S. Lea and G. R. Heckle, February 21st, 1914, as follows:—

Conclusions.

(11) That the reinforced concrete retaining wall as designed by the city and to be built by the Cook Construction Company along the banks of the aqueduct in the earth sections is not, as designed, a safe structure to build for the purposes intended.

(12) That a revision of the design of this wall, in order to make it safe, will greatly increase the cost of the project.

Recommendations.

(1) That before any further work is proceeded with, at least on the north side of the aqueduct, an investigation be made by a commission of engineers into the entire aqueduct scheme, which will include revised estimates of the cost of construction, and the quantity and cost of the power developed.

During our investigation of the intake conduit after its failure on December 25th, 1913, with which we were specially charged at that time, we had to deal with the question of this retaining-wall which it was proposed to build to support the banks of the aqueduct in which the conduit was embedded, and which our computations clearly showed was entirely lacking in sufficient strength for the purposes intended.

We also obtained other information which clearly indicated that this aqueduct power development was not an economic proposition, and that the excessive cost would impose a heavy burden on the city from which an adequate return in power development could not possibly be obtained. It was these facts which convinced us, after mature deliberation, that it was our duty to make the recommendation that a commission of engineers should be immediately appointed to investigate the whole aqueduct power project with the conviction that a modification of the whole scheme might be made which would save the city a large sum, and also heavy expense in litigation with the contractors.

You will note that the report referred to has been in possession of the board of control, city engineer, etc., for sixteen months, during which period all work on the north bank of the aqueduct has been suspended at a heavy cost to the city for lack of prompt action by the board of control on the recommendations made. Mr. Janin at that time strenuously contended that his design of wall was safe, which contention has now been absolutely disproven by results on the test section, which

*See *The Canadian Engineer* for March 5th, 1914.

clearly show that walls of fully three times the strength of the original design are required for the purpose. Please note that the cost of building these test sections—which were obviously foredoomed to failure—and the cost of carrying out the tests would have paid for a large amount of expert engineering advice and have saved the greater part of this delay.

Immediately following your election as a member of the board of control and your taking special charge of the public works department of the city, the writer had several interviews with you, during which we drew your attention to the above and strongly urged you to immediately act on our recommendation.

We further advised you that in view of the importance of the question to the city and the conflict in opinion between the city engineer, who was responsible for the promotion and design of the project, and ourselves, that it was our desire to see appointed an entirely new commission composed of engineers, skilled and experienced in hydraulic power development, and who had not previously been employed by the city. We also advised you that all the information which we had obtained in connection with the aqueduct enlargement while investigating the conduit would be placed at the disposal of any commission of engineers appointed by the city.

You expressed yourself as fully impressed with the importance of this matter, requesting the writer to submit the names of qualified engineers for the proposed investigation—promised to take the matter up with your colleagues without delay and have the commission appointed. You, however, entirely failed to supplement this promise, with the result that no action has yet been taken to safeguard the city's interest, or to see what modification in the plans might yet be made with a view to saving a large outlay by the city.

The first appropriation of $2,000,000 for carrying out this power development was voted by the city seven years ago, and it is understood that plans and specifications have not yet been prepared for the power house, water wheels, pumps, electrical equipment, regulating gates, bridges, etc., or in fact for any part of the development beyond the big ditch, which is being excavated, and the retaining-walls.

These retaining-walls have not yet been built, and if built according to the revised plans will cost approximately $2,000,000, which is more than the total commercial value of the entire development. They are entirely unnecessary, either for the aqueduct or for the support of the conduit. The banks can be sloped in accordance with the usual practice in canal or head-race construction, and thus save the greater part of this money. Other large savings could undoubtedly be effected by a complete revision of the plans and good economical designs.

I have before me various reports and estimates prepared by Mr. George Janin, city engineer, and submitted to the city councillors and board of control as follows:—

Mr. Janin's original estimate of the cost of the aqueduct enlargement scheme, complete, appears to have been $2,200,000, including the proposed concrete conduit from the river to the pumping station, to supply the city with water during the aqueduct enlargement.

In 1907 the city council acted favorably on Mr. Janin's scheme and appropriated $2,000,000 to carry out the work. The contract for the intake conduit was awarded to Mr. P. McGovern in 1907, and the work completed in 1908. In October, 1909, contract was awarded to Messrs. Quinlan & Robertson for the Aqueduct Enlargement No. 1.

In April, 1910, Messrs. Hering & Fuller, consulting engineers, of New York, were retained by the city to make studies and reports on an improved water supply. (See report dated July 2nd, 1910.) In this report Messrs. Hering & Fuller recommended the construction of a double system filtration plant of 50,000,000 gallon capacity, and very strongly endorsed Mr. George Janin's scheme of power development by enlarging the aqueduct which was then under construction, the wisdom of which had been questioned by many engineers.

Under date of November 3rd Mr. Janin submitted to the board of control a report endorsing Messrs. Hering & Fuller's recommendation and plans for a 50,000,000 gallon double system filtration plant, and recommending that $1,687,000 be voted to complete the plans and for carrying out the work, and $318,670 for the purchase of land.

In the same report a further appropriation of $675,000 is requested for completion of work of enlarging the aqueduct, then in course of execution, and also proposes and recommends a still further enlargement of the aqueduct to produce 10,000 h.p. at an extra cost of $2,300,000 for aqueduct, tail-race, power house machinery, turbines, pumps, electric equipment, etc. Mr. Janin in this report states that the cost of producing power from this development will not exceed $12.62 per horse-power-year.

The board of control recommended this extension of the works, now known as "Aqueduct Enlargement No. 2," and under date of July 17th, 1913, a contract for the excavation of the aqueduct and tail-race, with reinforced concrete retaining-walls and extension of the intake, was awarded to the Cook Construction Company on a unit price basis and an estimated cost of $2,250,000, and the excavation has been proceeding more or less since that date.

The power house hydraulic and electric machinery, bridges, regulating gates, etc., have not yet been designed or put under contract.

According to the report of Mr. Paul E. Mercier, deputy chief engineer, June 16th, 1915, the total estimated cost of the power development is $6,020,426, but this does not include the cost of the intake conduit, the extension of the intake out into the river, as per contract Laurin & Leach, or the amount paid to Messrs. Quinlan & Robertson for aqueduct excavation, understood to be $835,000, so that the cost to date, plus the cost to complete, is likely to be $7,500,000 for a development estimated by Mr. Janin to be capable of producing 10,000 h.p. We will deal with this power estimate and also with the above cost of power production later.

Messrs. Hering & Fuller, of New York, in their "Report on an Improved Water Supply for the City of Montreal," July 2nd, 1910, referring to Aqueduct Enlargement No. 1, say as follows:—

On February 27, 1905, Mr. George Janin, Chief Engineer, addressed a report to the water committee making plain the economical advantages of enlarging the aqueduct which, with its original dimensions, was too small to provide an adequate quantity of water for the city, owing to the rapid growth in population and in amount of water consumption since the installation of the original works. This report shows that a substantial economy will result from the enlargement of the water power development when comparison is made of the interest on the necessary investment for this enlargement as distinguished from the cost of coal to develop an equivalent amount of power.

The report of Mr. Janin was acted upon favorably by council on March 9, 1907, and an appropriation of $2,000,000 was made for carrying out this work, together with the proposed new intake and the closed conduit for carrying the supply to the pumps.

With respect to the enlarged aqueduct (Enlargement No. 1), our examination of the plans and detailed computations of the volume of water and amount of head or fall available during severe winter conditions, leads us to the conclusion that there will be regularly available upon the completion of the enlarged aqueduct or head race, about 2,500 horse-power. This power is the maximum that can be made available regularly during the most unfavorable winter conditions. It refers to brake horse-power, or the available horse-power upon the shaft after making due allowance for the losses in the turbines.

As to the amount of horse-power which will ordinarily be available during the warmer season of the year, the quantity is limited somewhat to a rate of flow which will not produce a scouring velocity on the sides of the enlarged aqueduct. Our computations show that on a reasonable assumption the horse-power available in warm weather, measured on the shaft as above stated, will be practically double that available during the most unfavorable winter conditions, or about 5,000 horse-power. This should be available about nine months each year.

We understand the question has been raised as to whether it is judicious to spend the money for the enlargement of this aqueduct or head race. To answer that question it is necessary to compare the interest charges upon the investment of about $2,500,000, estimated to be necessary for the construction of the enlargement of the aqueduct as now planned (including the conduit) with the cost of coal to develop by steam an equal amount of power.

Placing the interest charges at 4.5 per cent. we obtain the sum of $101,250. Against this is to be placed the cost of coal to generate by steam an equal amount of power and which we find to be about $175,000, in order to produce 2,500 horse-power during the balance of the year. It is thus seen that there is no question about economy in the enlargement of the aqueduct from a business standpoint.

In this connection it is proper to point out that this conclusion at which we have arrived by our own examination and computations is in harmony with those of a long list of engineers who have examined into this question during the past half century—namely, Messrs. Keefer, Jarvis, McAlpine, L. Lesage, Francis, Shanley, Vanier, Kennedy, Marceau, Janin and T. W. Lesage.

Further, we desire to make it plain that the sound business basis for the enlarged aqueduct holds true regardless of whether the available water power is utilized for pumping water through the mains to the reservoirs of the city distribution system, or whether the power is used by the city for generating electricity or other purposes, or marketed in other ways than by its utilization for municipal requirements. This water power development is a sound, practical business proposition on its own merits and there should be no concern felt on the part of taxpayers as to the wisdom of expenditures for this improvement.

According to the foregoing report by Messrs. Hering & Fuller, previous to July, 1910, the total estimated cost of the power development, known as "Aqueduct Enlargement No. 1," which was at that time under construction by Messrs. Quinlan & Robertson, and the concrete intake conduit for supplying the city with water during the aqueduct enlargement, and which had already been completed by Mr. P. McGovern, was estimated to be $2,500,000 for a development of 2,500 horse-power maximum during the winter months. This gives a capital cost of $1,000 per horse-power against an average cost of not over $125 per horse-power for hydro-electric power developments throughout Canada, which is far from being a "sound, practical business proposition on its own merits."

In 1905-1910, it should not have been a question of comparison between the cost of power generated by the proposed aqueduct development and pumping the city water supply with steam generated by the antiquated and wasteful pumping plant owned by the city. The comparison should have been made between the capital cost of the aqueduct development, or the cost of generating power by it per horse-power-year, and the price at which the city could have purchased hydro-electric power, or have purchased and developed a water power in the neighborhood and transmitted the power to the city for their own use and for sale.

In their report Messrs. Hering & Fuller state:—

> That this conclusion at which we have arrived by our own examination and computations is in harmony with those of a long list of engineers who have examined into this question during the past half century.

This reference is obviously based on the untenable assumption that the science and practice of engineering has not advanced during this period and entirely ignores the important development in the electrical transmission of energy during the past 25 years, which has made it economical to develop hydraulic power at points where it could be developed most cheaply and delivered at points of consumption by transmission lines at a price very much below the cost of generating from coal, or by such local development as the aqueduct. Practically all the engineers referred to made their studies of the Montreal aqueduct project long previous to development of modern electrical transmission, which has entirely changed economic conditions in regard to power.

Hydro-electric engineers of high standing and conversant with the facts compute the cost of development of hydro-electric plants per horse-power as follows:—

Average cost of hydro-electric development throughout Canada, $125 per h.p.

Average Niagara Falls development, $110 per h.p.

Average cost of various developments within a transmission radius of Montreal (Chambly and St. Timothe, Canada Light and Power Company excluded), $107 per h.p.

Cedars Rapids, 100,000 h.p. now completed and in operation, $90 per h.p., and when the full 160,000 h.p. is completed, $75 per h.p.

These costs of development per horse-power are based on the maximum power obtained during the low-water season, or under conditions in winter, and cover the entire cost of the development, including the hydro-electric machinery and equipment ready to generate electric energy, but do not include the transformers or the transmission lines to deliver the electric energy at points of consumption. The cost of these latter varies with the distance, but may safely be taken for Montreal district at an average capital cost of $15 per h.p. between the different plants and the sub-stations within the city limits.

The amount of power which can be obtained from the aqueduct now under construction by the city depends on the net head of water obtainable at the power house during the winter months and the volume of water available under this head. Computations based on the data available show that during the winter months, when the aqueduct will be covered with ice and back-water in the tail-race, governed by the average level of the water in the St. Lawrence at the point of discharge, a total of 7,500 h.p. may be obtained under good normal conditions. This amount of power is, however, liable to be greatly reduced during severe winter weather by floating ice and frazil formed in the open water of the river between the intake and Lake St. Louis, and drawn into the aqueduct by the large quantity of water required to generate the power. That frazil trouble is more than a probability is shown by the experience of the Lachine Rapids development of the Montreal Light, Heat and Power Company, located a short distance below the aqueduct entrance, from which it is well known that only a very small amount of power can be obtained during the winter months, due to frazil blocking the forebay, racks and wheel-pits.

The aqueduct power will always be greatly reduced during the spring ice-jam below the city, and always liable to be drowned out by back-water each spring for periods of a week or more.

Under these conditions it will be necessary for the city to maintain an auxiliary steam plant to pump the city's water supply and generate electricity for the operation of the filtration plant, lighting, etc., and operate it for a probable period of from one week to three months each year, or purchase hydro-electric power for these purposes.

It is, no doubt, preferable for the city to own and control its own power plant for pumping as well as owning its own water supply system, providing they could generate their power at a reasonable cost, or which would compete with the price at which they might be able to purchase it. If the city authorities had acted like business men they would have, before committing themselves to this wild aqueduct project, had the problem of power development studied and reported upon by qualified and experienced hydro-electric engineers familiar with our winter conditions. It would, no doubt, have been found that for much less money than the city is now spending on the aqueduct a power site in the vicinity of Montreal could have been found and developed which would have produced from five to seven times the amount of power, which could have been sold to power and light consumers in the city at a low price, and which would have given the city electric energy for all their power and light requirements free of cost for all time to come.

This aqueduct scheme, if carried out in accordance with the present general plans, will apparently cost the city for power development alone $7,500,000, and this based on the probable power obtainable under good, normal winter conditions, will equal a cost of $1,000 per h.p. for development, or over eight (8) times the average cost of hydro-electric development in the vicinity of Montreal, including the necessary transmission lines to deliver the electric energy within the city limits.

This is an unprecedented cost for a power development in any part of the world, and particularly for a hydraulic development which will require an auxiliary steam plant or hydro-electric standby equal to nearly 100 per cent. of its normal capacity.

According to the city's estimates and the present state of the work, there is yet about $5,000,000 to be expended to complete this project, and it is understood that even the plans and specifications for the greater part of the remaining work, consisting of power house and forebay, pumps, hydro-electric machinery, bridges, regulating gates, etc., have not even been prepared so that an accurate estimate of their cost may be made. The retaining-walls, which will have a total length of twelve (12) miles, and which, according to the revised stronger design at the increased unit price to be allowed the contractors will cost about $2,000,000, have not yet been built. In fact, the work accomplished to date practically only consists of about 80 per cent. of the earth and rock excavation of the aqueduct. The contemplated construction of these retaining-walls might and should be abandoned. This would reduce the amount of power, but would effect a saving of nearly $2,000,000, which is well worthy of serious consideration.

In reference to representations made to the "Committee of Aldermen" on their recent visit to the aqueduct: "That the retaining-walls were urgently required to prevent another failure in the conduit," the writer has a very full knowledge of the condition of the conduit and the banks of the aqueduct in which it is embedded, and cannot find any justification for this claim. While the conduit is not of the best design, and was not nearly as heavily reinforced with steel as it should have been when constructed for the purpose intended, it is now, after the repairs made to it during 1914, quite safe if left undisturbed by further overload or excavation too close to it.

These retaining-walls are unnecessary, either for the aqueduct or for the support of the conduit. The banks can be sloped up as per usual practice in aqueduct, canal or head-race construction, and as per the plans of "Aqueduct Enlargement No. 1," and this sloping bank will be much safer for the conduit than if the retaining-walls are built, the reason for this being that, to enable the walls to be built on the lines shown by the revised plans, the excavation of the prism of the canal will have to approach much closer to the conduit than if the banks are simply sloped in the usual manner; in fact, the failure of the conduit on December 25th, 1913, was chiefly due to the excavation for these proposed walls being carried too close to the conduit.

As a citizen, taxpayer and engineer conversant with the existing state of affairs in connection with this aqueduct development, and having no prejudice or other interests to affect a fair judgment, we are strongly of the opinion that no further money should be voted or expended on any part of this work until the whole project has been studied and reported upon by thoroughly qualified hydro-electric engineers. This study, we believe, should result in a large saving to the city and in clearing up a most discreditable state of affairs.

Yours truly,
(Signed) J. A. Jamieson.

PENNSYLVANIA RAILROAD TEST DEPARTMENT.

The indifference of American manufacturers to the benefits of maintaining adequate laboratories of inspection and research, as compared with the activity in that field of foreign industrial organizations, has been commented upon by Mr. C. D. Young in a recent issue of the "Railway Age Gazette." He refers to a notable exception to this rule to be found in the description of the splendid development of the Pennsylvania Railroad Test Department in a paper read at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 22 to 26, 1915. From its humble beginnings in 1874 the work of the department has increased at an average rate of over 100 per cent. in each year, till the number of routine physical tests conducted reached, in one year, a total of 120,000, the carrying out of which required the services of 300 employees. Although the cost of operating this department for one year, $534,000, seems enormous, it amounts to only 0.6 per cent. of the material inspected and tested.

The British Board of Trade returns for June show that the imports of pit-props into England in that month totalled 180,466 loads, as against 329,128 loads in June, 1914. The quantity in the half-year was 1,084,542 loads, as compared with 1,186,573 loads in the corresponding period.

WEIGHT-VOLUMETRIC PROPORTIONING OF CONCRETE AGGREGATES IN TESTING.*

By J. A. Kitts.

VARIOUS methods have been devised for measuring volumes of cement, sand, and rock. One difficulty encountered in making a purely volumetric measurement of these materials is to place them in the vessel in such a manner that a uniform degree of compactness will obtain in each measurement. Another difficulty is due to the irregularity of the surface of the materials. In measuring a given volume the accuracy depends, necessarily, upon a single measurement. We may, however, determine the volume of a certain mass of material accurately by making several measurements.

If several determinations are made of the specific gravity and percentage of voids, and means are taken to obtain the full range of compactness in determining the percentage of voids, we may obtain a reliable figure for the apparent specific gravity of the material for average compactness. We may then weigh out volumes of the material with uniformity, and will have before us both weight and volumetric proportions, the volumetric proportions being the essential information.

Variability of Volume in Weight Proportioning.—From elementary principles we have:

Volume = Weight ÷ Specific Gravity.

We are not, however, dealing with actual volumes, in the case of cement, rock, and sand, but with apparent volumes:

Apparent Volume = Weight ÷ Apparent Specific Gravity, and
Apparent Specific Gravity = (Unit Volume — Voids) Specific Gravity, or
Apparent Volume = Weight ÷ (Unit Volume — Voids) Specific Gravity.

It is evident, therefore, that the apparent volume per unit of weight decreases as the specific gravity increases, and that it increases as the voids increase.

Table I. shows the variations of the volumetric proportions of various sands in sand-cement mortars of normal consistency and of 1:3 proportions by weight; also the ratio of volume of cement paste to volume of voids in each case.

Table I.—Variations of Volumetric Proportions in 1:3 Weight Proportioning.

Sand No.	Specific Gravity	Voids, per cent.	Apparent Specific Gravity	Weight Proportions C'm't:Sand	Volumetric Proportions C'm't : Sand	Ratio of Cement Paste to Voids
1*a* ...	2.65	37.0	1.67	1 : 3	1 : 3.18	0.85
2 ...	2.74	35.2	1.78	1 : 3	1 : 2.97	0.95
3 ...	2.63	39.8	1.58	1 : 3	1 : 3.34	0.75
4 ...	2.78	36.6	1.76	1 : 3	1 : 3	0.91
5 ...	2.77	27.9	2.00	1 : 3	1 : 2.64	1.36

a Standard Ottawa Sand.

Assuming that 110 lb. of cement make 1 cu. ft. of cement paste of normal consistency, the apparent specific gravity of cement is 1.76; and the volumetric proportions as indicated in Table I., are determined as follows:

$$\frac{\text{App. Volume Sand}}{\text{App. Vol. Cement}} = \frac{3 \times \text{App. Sp. Gr. Cement}}{\text{App. Sp. Gr. Sand}} = \frac{5.28}{\text{App. Sp. Gr. Sand}}.$$

Is there any justification for comparing these sands in mixtures in which the proportions of voids filled with cement vary from 75 to 136 per cent.? If it is desired to determine the relative strengths of sands per unit measure of cement, the volumes of sands should be equal. We are not so much concerned, however, with the strength of mixtures of equal volumetric proportions as we are with the comparative costs per unit of strength of the most economical mixtures with the various sands. In general, the minimum cost per unit of strength will obtain when the volume of cement paste is equal to that of the voids.

Weight-Volumetric Proportioning.—If we wish to weigh out certain volumes of sand and cement for cement-sand mortar, with the object of using a certain volume of cement paste with a unit volume of sand, then:

$$\frac{\text{Weight of Cement}}{\text{Unit Weight of Sand}} = \frac{\text{App. Sp. Gr. Cement} \times \text{Proportion of Paste}}{\text{App. Sp. Gr. Sand}}.$$

Example:—To use 0.37 parts by volume of cement paste of normal consistency with one part by volume of standard Ottawa sand, the part of cement by weight is (1.76÷1.67) 0.37=0.390. The weight proportions then are 1 sand: 0.39 cement, corresponding to volumetric proportions of 1 sand:0.37 cement, or 1 cement:2.7 sand.

The writer finds it desirable to use sand as the unit of measure, when considering a mortar, as in any stated volumetric proportions the ratio of volume of cement paste to volume of voids in the sand may be estimated at a glance. It will be observed in the above example that the volume of paste is equal to the proportion of voids in the sand.

Weight-volumetric proportioning of concrete aggregates may be made in a similar manner as will be indicated below under "Progressive Proportioning of Concrete Aggregates."

Comparative Tests of Sands.—In making comparative tests of sands we should have like conditions in every case. If we have the same proportions by weight, or by volume, the ratio of volume of cement paste to volume of voids is different in every case. One mixture may be porous from too little cement while another may be dense but may have the sand particles widely separated by too much cement.

For like conditions, the consistency of the mixtures should be the same and the volume of cement paste should be equal to the volume of voids. The weight and volumetric proportions of sands Nos. 1 to 5 for comparative tests should be as shown in Table II. for mortars of normal consistency.

It may be considered advisable to use an excess of paste in each case, for example, 105 per cent. of the voids in the sands. The equation would then be:

$$\frac{\text{Weight of Cement}}{\text{Unit Weight of Sand}} = \frac{1.05 \text{ App. Sp. Gr. Cement} \times \text{Voids in Sand}}{\text{App. Sp. Gr. Sand}}.$$

The strength, or the cost per unit of strength, will indicate the most satisfactory sand.

Table II.—Volume of Cement Paste = Volume of Voids.

Sand No.	Specific Gravity	Voids. per cent.	Apparent Specific Gravity	Volumetric Proportions Sand : Cement	Weight Proportions Sand : Cement	Ratio of Cement Paste to Voids
1....	2.65	37.0	1.67	1 : 0.370	1 : 0.390	1
2....	2.74	35.2	1.78	1 : 0.352	1 : 0.348	1
3....	2.63	39.8	1.58	1 : 0.398	1 : 0.443	1
4....	2.78	36.6	1.76	1 : .366	1 : 0.366	1
5....	2.77	27.9	2.00	1 : 0.279	1 : 0.246	1

$$\frac{\text{Weight of Cement}}{\text{Unit Weight of Sand}} = \frac{\text{App. Sp. Gr. Cement} \times \text{Proportion of Paste}}{\text{App. Sp. Gr. Sand}}.$$

*Read at the 18th annual meeting of the American Society for Testing Materials, June 22-26. 1915.

Progressive Proportioning of Sand-Cement Mortar.—In making a study of a given sand it is advisable that the mortar be made of the same consistency as that to be used in the field. The most satisfactory consistency for general use is the initial flowing consistency. Approximately 94 lb. of cement makes one cubic foot of cement paste of this consistency and the apparent specific gravity for this consistency is 1.5. This is the initial degree of wetness that will cause the cement paste to flow, as a liquid, from a plane inclined at 45 deg. The amount of water necessary to make a paste of this consistency is approximately as follows:

34 per cent. of water by weight of dry cement.
39 " " " " volume " " "
50 " " " " " " resulting paste.

With this high percentage of water, necessary in the field, it will be recognized that the strength of a mortar of normal consistency is not representative of that of a mortar of the consistency under working conditions.

In order to determine the mortar of maximum density and also the mortar giving satisfactory strength, the progressive proportions in Table III. are suggested, as preferable to the usual proportions, for sand No. 1 in a mortar of initial flowing consistency.

Table III.—Progressive Proportions for Consistency Under Working Conditions.

Proportions by Volume				Ratio of Cement Paste to Voids	Proportions by Weight[1]		
Cement Paste, per cent.	Sand	:	Cement Paste		Sand	:	Cement
20	1	:	0.20	0.54	1	:	0.18
25	1	:	0.25	0.67	1	:	0.225
33.3	1	:	0.333	0.90	1	:	0.30
37*a*	1	:	0.37	1.00	1	:	0.333
40	1	:	0.40	1.08	1	:	0.36
50	1	:	0.50	1.35	1	:	0.45
66.7	1	:	0.667	1.80	1	:	0.60
100	1	:	1.00	2.71	1	:	0.90

a Volume of cement paste equal to volume of voids in sand.

[1] $\frac{\text{Weight of Cement}}{\text{Unit Weight of Sand}} = \frac{1.5 \times \text{Volume of Paste}}{1.67} = 0.9 \times$ Volume of Paste.

The mortar of maximum density may be determined by weighing the test specimens.

Progressive Proportioning of Concrete Aggregates.—Having determined the mortar of maximum density and satisfactory strength, progressive proportions of the mortar with the rock may be made in a similar manner as cement with sand.

An amount of rock equal to the volume of the test cylinder should be used for each test specimen.

The progressive proportions in Table IV. are suggested for the following cement, sand and stone:

Material	Specific Gravity	Per cent. of Voids	Apparent Specific Gravity
Cement	3.1	51	1.5
Sand No. 1	2.65	37	1.67
Rock	2.50	43.65	1.41

Test Cylinder: Diameter, 8-in.; length, 16-in; volume, 13.1793 liters.
Weight of Rock to fill Cylinder: 1.41×13.1793=18.583 kg.

The yield of mortar for sand No. 1 and 37-per-cent. cement paste, as used in Table IV., is assumed as unity.

The weight of the test specimens will indicate the mixture of maximum density.

Permeability specimens may be made in the same proportions.

Table IV.—Progressive Proportions of Mortar With Rock.

Weight of Rock, kg.	Ratio of Mortar to Voids	Mortar of "Work" Consistency.				Volumetric Proportions
		Per cent.	Volume, liters	Weight of Sand,[1] kg.	Weight of Cement,[2] kg.	
18.583	0.80	35	4.673	7.804	2.593	1 :2.7 :7.7
"	0.92	40	5.272	8.871	2.926	1 :2.7 :6.8
"	1.00*a*	43.65	5.753	9.575	3.193	1 :2.7 :6.2
"	1.05	45	5.930	9.937	3.291	1 :2.7 :6.0
"	1.15	50	6.589	11.004	3.657	1 :2.7 :5.4

a Volume of mortar equal to volume of voids in rock.

[1] Weight of Sand = $\frac{\text{Volume of Mortar} \times \text{App. Sp. Gr. of Sand}}{\text{Yield of Mortar}}$.

[2] Weight of Cement = $\frac{\text{Volume of Mortar} \times \text{Voids in Sand} \times \text{App. Sp. Gr. of Cement}}{\text{Yield of Mortar}}$.

Conclusions.—By this method of weight-volumetric proportioning we may obtain a fairly accurate knowledge of the action of various combinations of materials in mortars or concretes and the results, instead of being freaky, will be consistent to a degree not attainable by simple volumetric or simple weight proportioning. The advantages of this method are:

1. That volumes may be weighed with ease and accuracy;

2. That the proportions may be found with regard to the superficial volume, actual volume, or the volume of voids of the materials;

3. That the error of volumetric measurement due to variability of compactness and irregularity of surface is eliminated;

4. That the voids in sand may be accurately filled with cement paste and the voids in rock with cement-sand mortar.

A porous mortar or a porous concrete is not an economical mixture with reference to cost per unit of strength. A mortar with cement greatly in excess of the volume of voids in the sand is not an economical mixture. A concrete with mortar greatly in excess of the volume of voids in the rock is not an economical mixture. The vital changes in density, permeability, and cost per unit of strength take place by variations in the volume of the filling medium when this volume is in the vicinity of that of the voids. In progressive proportioning of mortars or concretes we may investigate a wide range of proportions including that in which the voids in the materials are filled; or, we may investigate a limited range in the vicinity of the voids, by means of the methods proposed, and thus determine the most economical proportions accurately and scientifically.

The exports of electrical equipment from Canada to the United Kingdom for the ten months ending May 30th, 1914, were £3,032, according to a table given in "The Electrical Review." The exports of this class of material for the ten months ending May 30th, 1915, were £23,309, or more than $100,000 increase. The exports of similar material from the United States to the United Kingdom for the same periods show an increase of approximately $4,300,000, the figures being £1,400,167, as compared with £535,397.

The question of using Nova Scotia coal by the British admiralty is being looked after by the province's agent-general in London, Mr. J. Howard. The provincial government claims that the collieries produce one thousand tons of washed nut coal daily, equal in every respect to Welsh coal, and it urges a test by the imperial government. It will be remembered that Nova Scotia offered 100,000 tons of coal to the admiralty as a gift in the early stages of the war, but the offer was not accepted, the reason assigned being the transportation difficulties.

Editorial

COAL PRODUCTS AND BY-PRODUCTS IN CANADA.

The present time is particularly opportune for discussing the question of establishing new lines of trade and commerce; for, on account of the war conditions in Europe, all industries are more or less dislocated as regards supply and demand; and manufacturers, everywhere, are taking stock of current conditions, and considering future possibilities. The trade possibility that would naturally occur to most people interested in the commercial development of Canada is the establishment of a coal tar dye industry; since here, as in other countries, factories using dyes are being seriously inconvenienced, owing to the fact that Germany—by a combination of scientific research, technical ability, and commercial energy—has for years had practically a monopoly in the manufacture and supply of coal-tar dyes; and consequently, since the opening of the war, importation of this commodity from Europe has almost ceased.

A report has just been issued by the Mines Branch, Department of Mines, Canada, dealing with the production and by-products of coal. This report, prepared by Mr. Edgar Stansfield, M.Sc., and Dr. F. E. Carter, B.Sc., shows that the importation of dyes into Canada is not large, and that the prospect of developing a flourishing coal-tar dye industry is not encouraging. But offsetting this negative view is a demonstration of the encouraging fact that there are other important by-products from coal which, although not figuring so prominently in the public eye, are nevertheless of much greater importance commercially. It is shown that a number of these are peculiarly suitable for production in Canada; and the Dominion could thus be rendered less dependent on foreign sources of supply.

The employment of coal for commercial purposes is roughly classified in the report under three main divisions as follows: (1) the combustible matter in the coal is completely burned with an excess of air; (2) the combustible matter in the coal is completely gasified by partial combustion with a limited amount of air, or of air and steam; and (3) the volatile matter of the coal is vaporized by the application of external heat in the absence of air.

In the first class, the coal is burned under steam boilers and in furnaces, etc. The coal is fed in and burned, heat is generated, and ashes are left. In this class heat is the main product, the only by-products being the valueless ashes and furnace gases.

In Class 2, the coal is gasified in the producer by blowing air and steam through it; but, by limiting the quantity of air supplied and having a deep layer of fuel, the coal is not completely oxidized, hence the gas produced is combustible. In this class the combustible gas is the main product, although ashes and heat are necessarily produced. The heat, which is generally kept as low as practicable by means of the steam, can be partially utilized, but is often a total loss. The gas is sometimes burned simply as a source of heat, while in other cases it is utilized as a source of power in internal combustion engines. As the gas leaves the producer it almost invariably contains more or less ammonia and coal tar, the quantities varying with the type of producer, with the amount of steam employed, and with the character of the coal gasified. By means of a suitable purifying plant the ammonia and tar may be recovered from the gas before it is used. These residuals are, therefore, by-products from the utilization of coal in gas producers.

In Class 3, the coal is carbonized in gas retorts for the production of coal gas, and in coke ovens for the production of coke. In both cases the coal is heated, gas and other volatile products pass off, and coke remains in the retort or oven; but in the coal gas plant the gas is the main product, the coke being only a by-product; whereas in the coke-oven plant the conditions are reversed, the gas being the by-product. In both cases, however, the gas, as it leaves the coal, contains ammonia and coal tar vapors, and these are recoverable by-products.

In *The Canadian Engineer* for June 24th, 1915, reference was made to the interest that is being taken in the United States as the result of the new demands which the war has caused that country to make upon her own coal-tar dye industry. The statements of Messrs. Stansfield and Carter of the Canadian situation, while not of an encouraging nature respecting dyes, invite extensive investigation into the matter of the manufacture of other by-products in Canada. The great importance of our bituminous coal fields is daily becoming better recognized as a medium from which coke, gas, ammonia and tar are produced. These are the main by-products obtained from the distillation of coal in gas retorts, or in coke ovens. These, however, and their derivatives, of which there are so many, have a good market in Canada, and the importations of many of them are large. The imports of coal in 1913 amounted to $47,949,119; of coke, $2,180,830; and of petroleum, $13,339,326. The entire coke-oven production in Canada during 1913 of gas, tar and ammonium sulphate amounted to only $866,150.

SHOWERS OF POWER SCHEMES.

Another accruement to the downpour of power schemes, of which the readers of this journal have read extensively of late, comes from the New York side of the Niagara River, and involves an expenditure of about $100,000,000 in damming the lower Niagara River, and developing two million horse-power of electrical energy for use on both sides of the boundary. This would be accomplished by constructing a 90-foot dam, just above Queenston and backing the water up practically to the foot of the Falls—incidentally tampering with Nature's franchise to the Whirlpool Rapids and perhaps putting this renowned and ardent utility out of business.

The proposal was presented last week to the Joint Legislative Commission of New York State by Peter A. Porter, who nearly 30 years ago introduced the original Power Development Bill.

There is no relation, we are given to understand, between this scheme and that of the Hydro-Electric Power Commission of Ontario, outlined in our issue of July 15th.

PRESENT KNOWLEDGE OF BEST METHODS OF CONCRETE ROAD CONSTRUCTION.

Part I.

Economic Efficiency Undetermined; Character of Constituent Materials and Their Proportioning.

A COMPILATION of exceedingly valuable and reliable information on the construction of Portland cement concrete pavements for country roads was issued last week by the Office of Public Roads, U.S. Department of Agriculture. The writers, Chas. H. Moorefield and Jas. T. Voshell, both experienced highway engineers in the senior division of the service, set forth in their pamphlet practical instructions for highway engineers and all others interested in road making.

There are varying opinions among municipal officials as to the feasibility of country roads constructed of concrete. The following is a summary of the chief points brought out in the discussion under consideration.

(1) The economic efficiency of concrete roads is undetermined at present, but the indications are that this type of construction will prove to be well suited for certain conditions.

(2) The one-course type of concrete pavement is greatly to be preferred to the two-course type, but there are conditions under which the adoption of the two-course type of construction may be justified.

(3) The proportion of cement to the sand and coarse aggregate combined should not be less than about 1 to 5, and the proportion of sand to coarse aggregate should not be less than 1½ to 3, nor greater than 2 to 3. Ordinarily, when gravel is used as coarse aggregate, the proportions may be made 1 part of cement to 1½ parts of sand to 3 parts of gravel, and when crushed stone is used as coarse aggregate, 1 part of cement to 1¾ parts of sand to 3 parts of crushed stone.

(4) All types of contraction joints which have yet been devised require careful and frequent attention in order to prevent rapid deterioration of the pavement in their vicinity. It appears that better results are obtained by spacing the joints at an angle of about 75° to the centre line of the road than when they are placed at an angle of 90°.

(5) Thin bituminous wearing surfaces for concrete pavements can not be economically justified at present. It is possible that through experimental investigations some method of constructing such surfaces to give uniformly satisfactory results may yet be devised. If this is done, the maintenance of concrete pavements and the contraction-joint problem will be greatly simplified.

(6) Intelligent engineering supervision is absolutely essential in concrete pavement construction, because defective materials or workmanship cannot be readily repaired after the pavement is completed, and they are not usually apparent until the pavement has been in use for some time.

With regard to the materials, for use in construction, the writers present the following conclusions:—

It is especially desirable that concrete for road pavements should possess, in as great degree as practicable: (1) hardness, in order to resist the abrasive action of traffic; (2) toughness, in order to resist the disintegrating action of horses' hoofs and other shocks; and (3) homogeneity, in order that the surface may wear uniformly.

The character of the constituent materials and the proportions in which they are mixed both have a marked influence on the degree in which these qualities are possessed by the concrete. In selecting the materials and determining the proportion in which they are to be mixed, the prospect of securing the desired qualities in the resulting concrete should be given primary consideration. The methods of mixing, depositing, and curing the concrete are also important factors in securing satisfactory results.

Materials.—No hard and fast rules can be laid down which would fit all cases in the selection of concrete materials, as availability is necessarily a very important factor. Satisfactory cement can usually be obtained, and none should be used in constructing pavements which does not meet all requirements for a high-grade Portland cement. The cost of importing the sand and coarse aggregate from any considerable distance is usually prohibitive, and if there are any local materials which are or can be made suitable for aggregates they should be given first consideration. But if the local materials are not such as to meet substantially the requirements outlined in the following paragraphs, it would be very doubtful economy to use them.

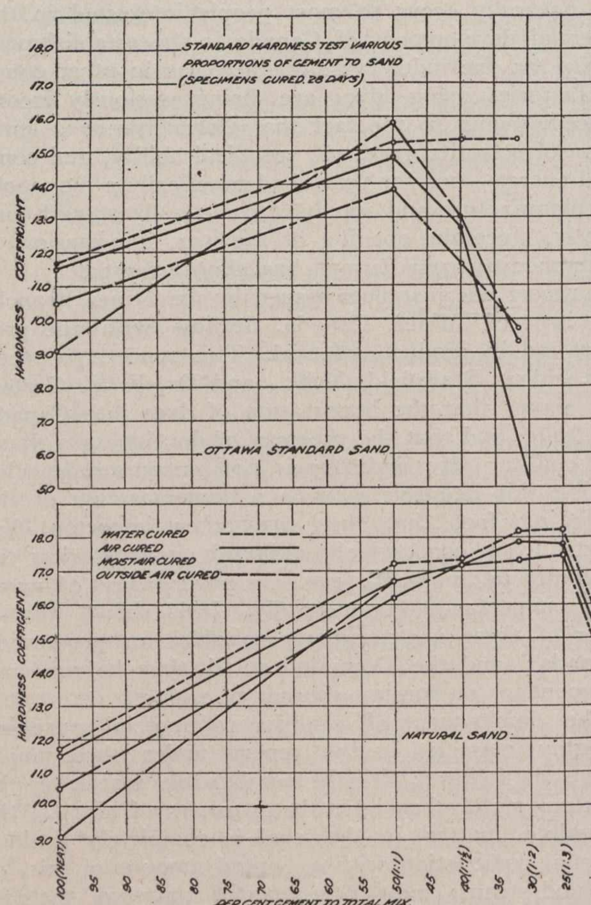


Fig. 1.—Diagram Showing Results of Hardness Tests of Cement Mortars.

Portland cement of a character satisfactory for use in pavement construction is at present manufactured in nearly every section of the country. The product of all cement plants is not always entirely uniform and of equal excellence, and even if it were uniform immediately after manufacture this condition might easily be changed by age or exposure. These facts make it imperative that cement for use in concrete pavements be subjected to very rigid inspection.

Sand for use in concrete pavements should be selected with especial care. The strength of mortar depends almost, if not quite, as much on the quality of the sand used as on the quality of the cement, and a strong mortar is imperative if the best results are to be obtained. Preference should be given to sand composed of a mixture of coarse and fine grains, with the coarse grains predominating, though sand consisting entirely of coarse grains is preferable to that in which the fine grains predominate. It is also very important that the sand be as clean as practicable. Sand which contains more than about 3 per cent. of foreign materials, such as loam or clay, should be rejected, and no sand should be used the grains of which are coated with clay or other objectionable material.

Sand which contains even a very small percentage of vegetable acids is unsuitable for use in concrete, because such acids seriously affect the strength of cement. It is not always easy to detect the presence of acids in sand, and in order to insure that they are not present in any

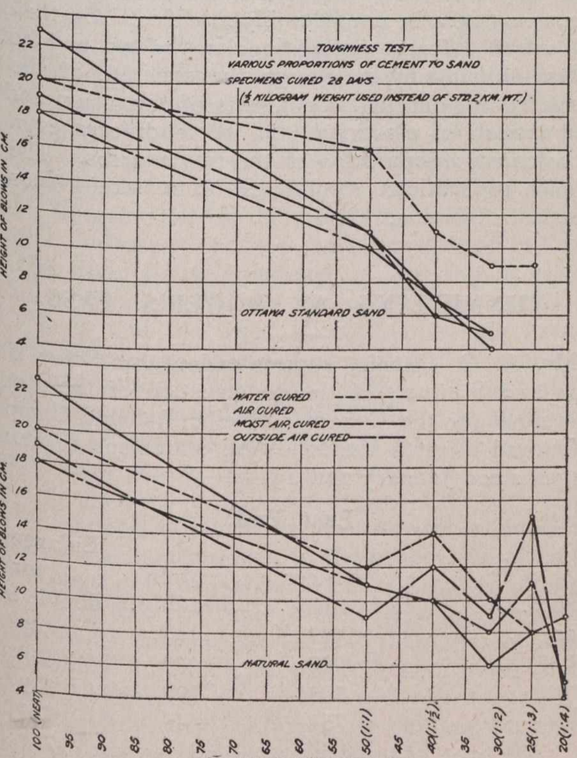


Fig. 2.—Diagram Showing Results of Toughness Tests of Cement Mortars.

great extent it is well to specify that cement mortar in which the proposed sand is used will develop a tensile strength equal to that developed by mortar made of the same cement and standard Ottawa sand.

The coarse aggregate may consist of either crushed stone or gravel. It has been claimed that the angular shape of the particles of crushed stone gives that material an advantage over gravel in the matter of securing a satisfactory bond with the mortar of the concrete, and this claim seems to be at least partially justified by experience. Wherever gravel and crushed stone have been used as coarse aggregates in different sections of the same pavement, and the different sections have been given identical treatment, a proportionally greater number of cracks have usually formed in the gravel concrete. It has been observed, however, that when some varieties of stone are used as coarse aggregate the resulting concrete shows very little, if any, superiority over gravel concrete as regards the formation of cracks. It therefore seems possible that the quality of stone, rather than the angular shape of the particles, may be responsible for the apparent advantage of crushed stone over gravel.

There are not sufficient data available to warrant making a definite comparison of the advantages possessed by the different varieties of stone when used as coarse aggregate. But so far as cracks are concerned, limestone appears to have made a better record than any other variety of stone which has been used to any considerable extent.

The coarse aggregate, whether of crushed stone or gravel, should possess at least as great resistance to wear as the mortar which fills the voids between the particles of stone. Any sound stone or gravel, moderately hard and tough, will meet this requirement, but in general the harder and tougher the coarse aggregate, the greater the resistance to wear of the concrete. The best available stone should therefore always be used.

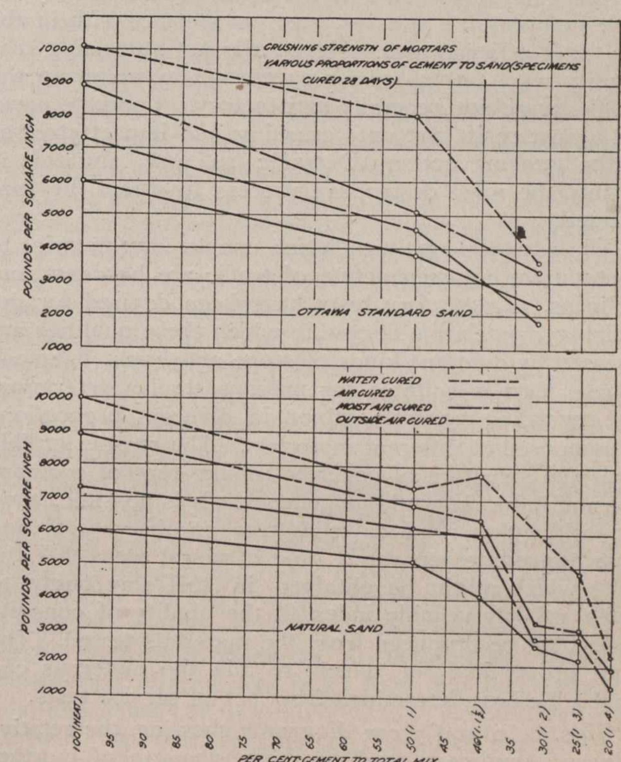


Fig. 3.—Diagram Showing Results of Crushing Strength Tests of Cement Mortars.

The difficulties experienced in securing a satisfactory quality of coarse aggregate are frequently caused by a lack of proper facilities for preparing the natural materials locally available. There are very few gravel pits which furnish a gravel suitable for use in concrete pavement construction without washing, and properly equipped washing plants are both difficult and expensive to construct. On the other hand, a great many stone quarries contain pockets of clay or inferior stone which should not be contained in the aggregate, and it is sometimes very difficult to remove these objectionable materials while the stone is being crushed and screened. It is also frequently difficult to screen out the dust of fracture formed in crushing some varieties of stone.

It is very desirable that the particles composing the coarse aggregate be well graded in size between proper limits in order that the percentage of voids may be as small as practicable. It is convenient to fix the limit of variation by specifying a certain screen upon which coarse aggregate shall all be retained, and another screen which it shall all pass. A ¼-inch mesh screen for the lower limit and a screen having 1½-inch circular openings for the upper limit have been most frequently specified for coarse aggregate used in concrete pavements. The upper limit of 1½ inches seems to be entirely satisfactory in nearly all cases, but the lower limit of ¼ inch frequently results in a failure to remove as much fine material from the aggregate as is desirable. For example, when the coarse aggregate is secured from gravel containing a considerable percentage of sand, or from crushed limestone, a ⅜-inch mesh minimum screen is to be preferred.

Water used in mixing concrete should be reasonably clear and free from alkalies, acids, vegetable matter, or other injurious materials.

Proportioning.—Concrete in pavements is subjected to much more severe service conditions than that in walls, foundations, etc. Most of the old rules for proportioning concrete were developed with a view to providing only for simple compressive stresses, such as are met with in the latter class of structures. Hence it is not surprising that the early results obtained for pavements by following the old rules were not generally satisfactory. Concrete pavements must resist not only crushing and impact stresses but the wearing action of traffic as well, and this is probably the most destructive process to which they are subjected.

The essential qualities which enable any material to withstand the wearing action of traffic are hardness and toughness. Laboratory tests have been devised for determining the relative degree in which these qualities are possessed by different kinds of stone and brick, but none of these tests is suitable for making similar determinations regarding concrete mixed in different proportions and composed of different materials. The reason for this is that the structure of concrete, unlike that of ordinary stone and brick, is not homogeneous. It is possible, however, to employ road-material tests on the mortar and coarse aggregate separately, and it would seem that the results which might be obtained in this way ought to furnish a fairly reliable index to the quality of concrete which could be produced from the materials tested. The proper proportions in which to mix the materials can probably be best determined from actual service tests.

Figs. 1, 2 and 3 are diagrams showing the relative hardness, toughness, and crushing strength of mortars mixed in different proportions and in which two different qualities of sand were used. Sand for one set of the test specimens, as noted on the diagrams, was standard Ottawa, while that for the other set was natural quartz sand which showed the following analysis:—

Table I.—Granulometric Analysis of Quartz Sand.[1]

Size of grains.	Grams.	Per cent.
Retained on—		
¼-inch mesh screen	0.0	0.0
⅛-inch mesh screen	74.0	5.9
No. 10 screen	124.5	10.0
No. 20 screen	266.0	21.2
No. 30 screen	460.0	36.7
No. 40 screen	624.0	49.8
No. 50 screen	930.5	74.3
No. 80 screen	1,139.5	91.1
No. 100 screen	1,159.5	92.7
No. 200 screen	1,198.5	96.5
Passing a No. 200 screen	51.5	3.5
		100.0

[1] Total weight of sample, 1,250 grams; weight of sample after washing, 1,208 grams.

Experience has shown that when first-class sand is used very good results are obtained by using a proportion of 1 part of cement to 1½ or 1¾ parts of sand and making the proportion of coarse aggregate such that the resulting concrete will contain slightly more mortar than is sufficient to fill all voids. If a well-graded gravel is used as coarse aggregate, the proportion should be about 1 : 1½ : 3, while in most cases where broken stone is used as coarse aggregate it will be found desirable to make the proportion about 1 : 1¾ : 3, and in some cases, where the particles of stone are of uniform size, even a still greater proportion of mortar will be required, but this should be effected by decreasing the amount of coarse aggregate and not by further increasing the amount of sand.

Since the bottom course of a two-course pavement is not subjected to the wearing action of traffic, it would appear that the rules for proportioning the materials for this course might be considerably modified. On the other hand, using different proportions in the top and bottom courses undoubtedly results in the concrete of the two courses having different coefficients of expansion and different moduli of elasticity, and these differences might tend to cause a separation of the two courses. The fact that such separations sometimes occur strengthens this theoretical objection.

TUNNELLING AT ROGER'S PASS.

Mr. A. C. Dennis, superintendent for Foley Bros., Welch and Stewart, of the construction of the Roger's Pass tunnel for the Canadian Pacific Railway Company, has favored us with the following statement of monthly footages since January 1st, 1915:—

East End.

Month.	Pioneer heading.	Main heading.	Enlargement for double track.
January	592	443	443
February	620	440	422
March	595	*196	379
April	751	442	553
May	658	417	718
June	776	471	659
July	682	538	726

*Half month.

West End.

Month.	Pioneer heading.	Main heading.	Enlargement for double track. (Timbered.)
January	932	699	210
February	650	634	247
March	617	752	413
April	569	741	588
May	730	618	685
June	808	393	729
July	731	*969	812

*Two headings.

The pioneer heading has been completed and there remain to be driven 2.05 miles of main heading and 3.31 miles of double track tunnel enlargement. Concrete lining of the earth section is nearing completion and it is expected that concreting of that portion of the rock section which requires lining will be finished this year. The completed tunnel will probably be ready for operation in September, 1916.

COAL TAR IN ENGINEERING INDUSTRIES.

THE commercial aspect of the relations of coal tar products to certain large industries with which engineering is closely associated is of a very interesting nature. An idea of the vast technical importance of a number of the by-products of coal may be readily obtained from the report on "Products and By-products of Coal," recently issued by the Dominion Department of Mines, from which report the following information is extracted:—

Timber Preservation.—Wood, when exposed to moisture, or set in water, may decay through the action of different organisms or fungi; or it may be destroyed by insects. To prevent this, the timber is soaked in some chemical which will act as a poison to such enemies. Mercuric chloride, copper sulphate, and zinc chloride, are examples of suitable poisons, and of these the last named is widely used. They are, however, all soluble in water, and may be washed out by rain, etc. Creosote oil, on the other hand, is an efficient preservative which is insoluble in water and consequently is more permanent in its action. It gradually evaporates, but, if a heavy oil be chosen, the rate of evaporation is very slow. Coal tar—also insoluble in water—is often used; but its penetrating power is small. Creosote oil is, therefore, the most suitable material for timber preservation, and is most used in Canada.

The wood to be preserved is put into iron tanks, which are then closed and evacuated; the heated oil is now run in and the wood allowed to remain immersed under pressure for some time to ensure the complete filling of the pores. The preservative, to be effective, should contain high-boiling oils; for general purposes not more than 50 per cent. of it should distil below 315° C., but for wood paving blocks not more than 55 per cent. should distil below that temperature. Economy of creosote oil can be obtained by the use of an inferior oil, which should be mixed hot, in the proportion of 80 parts oil to 20 parts of coke-oven tar, the latter containing not more than 5 to 6 per cent. of free carbon. The penetration of such a mixture is not less than that of creosote oil, if the time for which the timber is kept under pressure be slightly increased.

On the American continent the demand for creosote oil is much greater than the supply. In 1913 the United States consumed, for timber preservation, over 90 million gallons (Imp.) of the oil, and of this 62 per cent. was imported from Europe. Between 60 per cent. and 70 per cent. of the total quantity of oil consumed was used for the treatment of railway ties, some 25 million being thus treated. In Canada, 19 million cross-ties are used annually, and only about 10 per cent. of these are creosoted; but even for this comparatively small number, Canada does not produce sufficient creosote oil. If all the tar produced in gas and coke-oven works in the country were distilled, the home supply of creosote oil would still be quite unequal to the demand, and tar distillers would therefore be certain of a sale for one of their most important products.

Road Making.—Raw tar is sometimes used in the making of roads; but it is better to employ the prepared or dehydrated tar. This is generally poured or sprayed on existing roads. In dry weather it serves to keep the surface free from dust, and in wet weather it protects the road material from the disintegrating effects of water. In the actual construction of roads coal-tar pitch and asphalt are much used instead of tar. Coal-tar asphalt is made by mixing pitch with suitable quantities of creosote and anthracene oils; and, although it cannot entirely replace the natural asphalt in street paving, it is a very good substitute. For making sidewalks a mixture of coal-tar pitch and natural asphalt is often employed, sandy material being ground up with the mixture, which is then melted and mixed with gravel.

The use of pitch, etc., in the making of roads is increasing rapidly; and even at the present time there is a good demand for this residual material from the distillation of coal tar.

Explosives.—Phenol is the parent substance of several important explosives, and most of the carbolic acid produced is used in their manufacture. By the nitration of phenol, picric acid is formed, and this acid and its still more explosive salts are utilized in the preparation of such explosives as lyddite, melinite, etc. Trinitrotoluene and trinitrobenzene are also used in various preparations for the manufacture of explosives; the corresponding dinitro compounds explode only when admixed with saltpeter, etc.

Power Production.—In addition to the use of tar as a fuel, some of the products of distillation are useful for power production. The most important is benzol, which is being increasingly used in internal combustion engines, since it has a higher heating value than petroleum spirit, and does not appear to deposit much more carbon in the cylinder. The technical benzol, consisting of 95 per cent. benzene and 5 per cent. toluene, is generally used for this purpose. Until the value of naphthalene in the preparation of colors was discovered, that substance was considerably used as a fuel; it is still sometimes used for heating purposes, being injected in the liquid state into furnaces as was described for tar; and is also used for driving explosion motors. Heavy coal-tar oil also finds some application as a fuel.

The introduction of the Diesel engine has opened up a new and important use for heavy oils. The great success with which the Diesel engine has already met is due partly to its simplicity and economy, and partly to its adaptability for using many kinds of liquid fuel. Although most kinds of crude oil are applicable, it is preferable partially to refine the fuel before use. It has been shown that mineral oils freed from benzene, lignite tar oils, and animal or vegetable fat oils, can always be used as fuel; but that coal-tar oil, and also vertical retort, water gas, oil gas, and coke-oven tars may be used only with the aid of special apparatus. Tars from horizontal or inclined retorts cannot be used. The following specifications for coal tar or tar oil for Diesel engines are given by Rath and Rossenbeck (Zeit. Ver. deutsch. Ingen. 1913, page 1490):—

1. Tar oils must not contain more than 0.2 per cent. of solids insoluble in xylol, nor more than 0.05 per cent. of incombustible matter.
2. Water must not exceed 1 per cent.
3. The residue on coking must not be greater than 3 per cent.
4. At least 60 per cent. by volume of the oil must distil over below 300° C.
5. The lower calorific value must not be less than 8,800 Cals. per kilogram.
6. The flash point must not be below 65° C.
7. The oil must be quite fluid at 15° C., and must not deposit solids on standing for half an hour at 8° C.

In Canada petroleum products for power production (gasoline and heavy oil) are much cheaper than in most European countries; so that benzol and other coal-tar distillates cannot readily compete with petroleum products as fuels in this country.

TRANSPORTATION COSTS IN THE UNITED STATES.

ADEQUATE transportation facilities are a vital factor in the prosperity and civilization of any country. They are essential to the development of its agriculture and manufactures, to the working of its forests and mines, and to the spread of education and enlightenment among its citizens. This necessity has been recognized by the foremost nations of every age and steps taken to meet it by improving the methods of transportation then current.

Writing in the 1914 year-book of the U.S. Department of Agriculture, Mr. J. E. Pennybacker, chief of road economics, U.S. Office of Public Roads, refers to the growth of the transportation problem in that country. He states that a movement for internal improvements was projected almost contemporaneously with the establishment of the federal government. This first took the form of highway improvement through the construction of toll roads by private corporations and the building of national highways by appropriations from the national government. These appropriations for national highways were continued by Congress for a period of nearly half a century, and a total of about $14,000,000 was thus appropriated. About 1832, however, the steam locomotive was first used in this country, and an era of railroad development followed. It was believed by many that the railroads would obviate the necessity for highway improvement, and, consequently, efforts at improving the public highways of the country were largely abandoned. During this period of activity in railroad construction many thousands of miles of railroads were built. The success attending this movement is evidenced by the fact that to-day there are in the country practically 244,000 miles of railroad, costing about $16,000,000,000, including equipment. This mileage carries annually more than 1,000,000,000 passengers and over 2,000,000,000 tons of freight. Railroad freight rates have fallen from 7⅓ cents per ton-mile in about 1837 to 7¼ mills per ton-mile at the present time, or about one-tenth the original rate, and yet, even at this low rate, the annual gross receipts of the railroads amount to about $3,000,000,000. The cost of ocean transportation has been reduced even more phenomenally than railroad transportation. It costs under normal conditions only 4½ cents per bushel to carry wheat from New York to Liverpool, a distance of 3,000 miles, which would be at the rate of one-half mill per ton-mile. These rates have remained practically unchanged for a number of years, indicating that we can not hope for much further reduction in cost by these methods of transportation.

Present Cost of Public Road Transportation.—It should not be assumed, however, that all of our transportation problems have been solved, nor that there can be no further saving in our cost of hauling. The public roads throughout the country, which constitute the primary means of transportation for all agricultural products, for many millions of tons of forest, mine, and manufactured products, and which for a large percentage of farmers are the only avenues of transportation leading from the point of production to the point of consumption or rail shipment, have been improved to only a slight extent. By reason of this fact, the prevailing cost of hauling over these roads is about 23 cents per ton per mile. More than 350,000,000 tons are hauled over these roads each year, and the average haul is about 8 miles, from which it can readily be seen that our annual bill for hauling over the public roads is nearly $650,000,000. The cost per ton-mile for hauling on hard-surfaced roads should not exceed 13 cents. It is therefore evident that if our roads were adequately improved a large annual saving in the cost of hauling would result.

RAILWAY CONCESSION TO FURTHER ROAD CONSTRUCTION.

A recent decision of the Board of Railway Commissioners for Canada is of considerable interest to municipalities concerned in the good roads movement.

Mr. J. D. Armstrong, M.P., made an application to the Board, requesting it to order that low commodity rates should be extended by the railway companies to the movements of gravel so as to enable the municipalities in western Ontario to proceed with the work of general road improvement at a reasonable expense.

Sir H. L. Drayton, Chief Commissioner, after hearing evidence given by the applicants and the railway companies, says in his decision: "The Board cannot order the companies to put in unremunerative rates, nor a rate so low as to be unfairly out of line with rates which are necessary to be maintained in order to permit the continuance of satisfactory operation of railways, due regard being had to proper consideration of the value of the commodities shipped and the service performed. While, therefore, I felt that it was impossible for the Board to make any order, the Board urged upon the companies the advisability of recognizing a public interest and the benefits which would result to the companies themselves from a proper system of good roads.

"The Ontario Government has also intervened, and is very desirous of obtaining extremely low rates, with a view to aiding the present campaign for good roads. The companies are insistent that they require more revenue, and that their rate returns as a whole are inadequate and insufficient, and, in the first instance, took the position that while they admitted the need of good roads, that, in view of their present necessities and of their present application for increase in freight rates, no concessions could possibly be made by them, as this would be construed as evidence that an increase in rates generally was not required. The railways have been assured that no such construction will be made by the Board.

"The railways now state that, regarding the question in the light of public policy and the possibility of increased railway business as a result of the added prosperity, and with the understanding that the rates offered are not to be regarded as indicating sufficient rates for similar commercial service, they will carry in the territory in question gravel that the municipalities require at a flat blanket rate of 50 cents per ton for any distance up to and including 50 miles, the rate to be a carload rate and cars to be loaded to their full stencilled carrying capacity, the gravel to be consigned to the clerk of the municipality and to be used for the purpose of road-making; and the railway companies to be notified in advance of the number of carloads required, so that special instructions may be issued in each case. It is anticipated that 50 miles will be the maximum haul, but should municipalities at further distances require the gravel the rate will be scaled down in the usual manner for greater distances."

COAST TO COAST

Rosedale, B.C.—The new Canadian Northern Pacific Railway depot at this point is practically completed.

Outremont, Que.—The city council has decided to buy a Vass combination sprinkler and flusher at a cost of $6,890.

Victoria, B.C.—Messrs. Parfitt Bros., contractors for the construction of the new armory and drill hall, state that it will be ready for occupation in October.

Calgary, Alta.—The 2,500,000 bushel grain elevator in the eastern part of the city will be completed and ready for use in a few weeks. The machinery is being installed at present.

Orillia, Ont.—Molybdenum, used in the manufacture of steel for guns and other armament, is now being extracted for the first time in Canada at a smelter in this vicinity. The ore is from Renfrew County.

North Bay, Ont.—The new Government trunk road between North Bay and Sturgeon Falls is now opened for traffic. The road extends a distance of 23 miles and has taken about a year and a half to complete.

Galt, Ont.—The retaining-wall that is being constructed by the Lake Erie and Northern Railway on State Street has been completed as far as Maple Street, and the forms are in place as far as Eliott Street.

Mimico, Ont.—The question of widening the Toronto-Hamilton highway from the Humber River west to the Etobicoke bridge, near Long Branch, is being actively taken up by the municipalities interested.

Galt, Ont.—The alterations to the electrical pumping plant are expected to be completed next week. Dr. Radford, chairman of the waterworks commission, states that the city uses over 12,000,000 gallons a year for sewer flushing.

Winnipeg, Man.—The improvements to the Canadian Pacific Railway subway at Main Street, and leading to the Winnipeg terminals, have been practically completed. The work has extended over two years, and is reported to have cost about $2,500,000.

Stratford, Ont.—The new sedimentation tank, grit and screen chambers at the sewage disposal works were completed and put into operation last week. This work was ordered by the Provincial Board of Health about 18 months ago. The cost has been about $16,500.

New Toronto, Ont.—The village is negotiating with Mimico with a view to having its sewerage system linked up with that of the latter. The plan will involve an expenditure of about $16,000 on 36-inch pipes; $45,000 on a pumping station, and will provide New Toronto with the facilities of the Mimico sewage disposal system.

Hespeler, Ont.—The installation of the waterworks system is being rushed. Numerous street mains and hydrants have already been installed, the standpipe is under construction and excavation for the reservoir under way. The water supply is derived from two wells drilled in rock to a depth of 100 ft.

New Liskeard, Ont.—The contractors have completed the piers and approaches for the bridge across the Ottawa River at North Temiskaming. Tenders are pending for the steel superstructure. The bridge, which is 640 ft. long, with one span of 238 ft., is costing about $100,000. Mr. J. H. Vermette, of the Department of Public Works, Ottawa, is supervising its erection.

Toronto, Ont.—The severe rain and wind storm on August 3rd did some damage to portions of the equipment of the Canadian Stewart Co. engaged in dredging and reclamation work near the mouth of the Humber River in Lake Ontario. The damage consisted chiefly in demolishing the pontoon pipe lines, although one large sand pump was temporarily put out of commission.

Toronto, Ont.—A reduction for 1916 of about $200,000 in the outlay on road construction in Ontario by the twenty counties operating under the Highway Improvement Act is indicated by recent estimates submitted to Mr. W. A. McLean, provincial engineer of highways. Last year's actual expenditure on road construction was $847,000, while the estimate for next year provides for an outlay of $640,000.

Berlin, Ont.—The trunk sewer claimed by certain members of the city council to be poorly constructed has been reported by Mr. Willis Chipman, Toronto, to be satisfactory, with a few minor exceptions. The report exonerates Mr. Herbert Johnston, city engineer, who was charged with inefficiency with regard to the sewer, which was taken over by the city from the contractors during its construction. The cost of the trunk sewer was $85,000.

Quebec, Que.—The new Bickell's Bridge, which is being constructed by the Sharpe Construction Co. to connect Hare Point with Stadacona, across the St. Charles River, is well under way. The coffer dam for the east abutment is in place and piling on the west side is being proceeded with. One span of the bridge will be a steel bascule lift structure, with reinforced concrete counterweights, and operated by electricity. The bridge will be 188 ft. in length and will rest on two centre piers. Both approaches will be supported by masonry walls.

Montreal, Que.—Mr. M. J. Butler, recently appointed consulting engineer to the city of Montreal in connection with its waterworks extensions, has recommended, according to report, the construction of a retaining-wall along the north side of the aqueduct. This additional precaution to the safety of the city water supply has been under consideration for some little time, and is estimated to cost $360,000. The council decided last week to proceed at once with its construction. The aqueduct contract is being carried out by the Cook Construction Co., and it is stated that no new tenders will be called for as the above company will do the work.

Victoria, B.C.—Improvement and reclamation work on the Songhees Indian Reserve, commenced last spring by the Department of Public Works of the British Columbia Government, largely as a solution to the unemployment problem, has been making good progress. The plan of development involves a retaining-wall of considerable length along the waterfront, the reclamation of an extensive area behind it, and the construction of a public road across it, extending from high level at the proposed terminal of Johnson Street to a subway at wharf level. The work is in charge of Mr. H. A. Icke, resident engineer, who states that up to date about 28,000 cu. yds. of earth and 7,000 cu. yds. of rock have been removed, Other features of the plan include two small park areas in the centre of the reserve and large spaces for industrial sites near the waterfront. The land will be traversed by common-user railway tracks, extending from the E. and N. bridge to Milne Street. The C.P.R. and C.N.P.R. will both extend their lines to reach these tracks. Two freight docks, a coal dock and a ferry slip form other parts of the scheme.

PERSONAL

Commissioner HARRISON is temporarily in charge of the Street Railway Department of the city of Edmonton.

J. R. MACLEOD has been placed in charge of the sewers department of the city of Montreal. For some years he has been in charge of municipal railways and tramways for the city.

ALEX. MARTIN has been appointed assistant chief engineer for the city of Montreal. Mr. P. E. Marcier has been acting chief engineer of Montreal during the absence of Mr. G. A. Janin, who is at present in France at the head of a company of engineers.

CHARLES A. STEWART has been appointed acting manager of the Temiscouata Railway, Riviere du Loup, Que., succeeding Mr. G. G. Grundy, whose death occurred recently. Mr. Stewart has been in the employ of the Temiscouata Railway since 1904. He is a native of Bathurst, N.B.

Brig.-Gen. A. C. JOLY DE LOTBINIERE, of Montreal, has been gazetted director of works in the British army. Prior to his departure for France he was engaged in hydro-electric work in India. He is a graduate of the Royal Military College, Kingston.

Lieut.-Col. A. E. HODGINS is organizing a corps of Royal Engineers in British Columbia. Col. Hodgins, who saw a good deal of active service in the South African war, has of late been connected with the British Columbia Department of Public Works, and formerly with the Grand Trunk Pacific Railway.

OBITUARY.

The death occurred at Halifax last week of Mr. J. R. Henderson, president and general manager of the Brandram-Henderson, Limited, of Montreal.

COST OF SHOAL LAKE AQUEDUCT.

The undertaking of the Greater Winnipeg Water District, that of constructing the Winnipeg-Shoal Lake aqueduct, is now computed to be costing only $11,640,567, instead of $13,500,000, as noted by the citizens. This saving is equal to the cost of the railway plus a margin of $749,433.

Contracts have been closed or arranged for every section of the work that will cover the entire district from Shoal Lake to the McPhillips Street reservoirs, and the cost of these will be $11,640,567.17.

Clearing the right-of-way required $79,366.34, instead of $55,000 as planned; the telephone line $30,500.46, instead of $25,000; and additional lands costing $77,571.81 had to be purchased, yet there was a saving of $14,340.11 on the Falcon River dyke and diversion; $1,509,860 on the aqueduct sectional contracts, and of $84,500 on cement.

The steel pipe line section will cost $1,100,000; the Indian Bay intake, $50,000; steel pipe line, $1,100,000; tunnel under the Red River at Victoria Park, $130,000; and the cast iron mains across the city to the McPhillips Street tanks, $278,000.

J. H. Tremblay & Co. is building the first section of the aqueduct for $945,945; Thos. Kelly & Sons, second section, for $1,301,485; and the Winnipeg Aqueduct Company, the other three sections, for $3,882,210.

COMING MEETINGS.

PACIFIC HIGHWAY ASSOCIATION.—Fifth annual meeting to be held in San Francisco, Cal., August 11th and 12th, 1915. Secretary, Henry L. Bowlby, 510 Chamber of Commerce Building, Portland, Ore.

PROVINCIAL ASSOCIATION OF FIRE CHIEFS.—Annual Convention to be held in Ottawa, Ont., August 24th to 27th, 1915. Secretary, Chief James Armstrong, Kingston, Ont.

NEW ENGLAND WATERWORKS ASSOCIATION.—Annual Convention to be held in New York City September 7th to 9th, 1915. Secretary, Willard Kent, 715 Tremont Temple, Boston, Mass.

AMERICAN ROAD BUILDERS' ASSOCIATION and AMERICAN HIGHWAY ASSOCIATION.—Pan American Road Congress to be held in Oakland, Cal., September 13th to 17th, 1915. Secretary, American Road Builders' Association, E. L. Powers, 150 Nassau Street, New York, N.Y. Executive Secretary, American Highway Association, I. S. Pennybacker, Colorado Building, Washington, D.C.

AMERICAN ELECTROCHEMICAL SOCIETY.—Twenty-eighth annual general meeting to be held in San Francisco, Cal., September 16th to 18th, 1915. J. M. Muir, 239 West 39th Street, New York City, Chairman of Transportation Committee.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Calvin W. Rice 29 West 39th Street, New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, F. L. Hutchinson, 29 West 39th Street, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Charles Warren Hunt, 220 West 57th Street, New York.

INTERNATIONAL ENGINEERING CONGRESS.—To be held in San Francisco, Cal., September 20th to 25th, 1915. Secretary, W. A. Catell, Foxcroft Building, San Francisco, Cal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—Annual convention to be held in San Francisco, Cal., October 4th to 8th, 1915. Secretary, E. B. Burritt, 29 West 39th Street, New York.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual convention to be held in Dayton, O., October 11th and 12th, 1915. Secretary, Will P. Blair, B. of L. E. Building, Cleveland, O.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Annual convention to be held in Dayton, O., October 12th to 14th, 1915.. Secretary, Charles Carroll Brown, 702 Wulsin Building, Indianapolis, Ind.