PAGES

MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

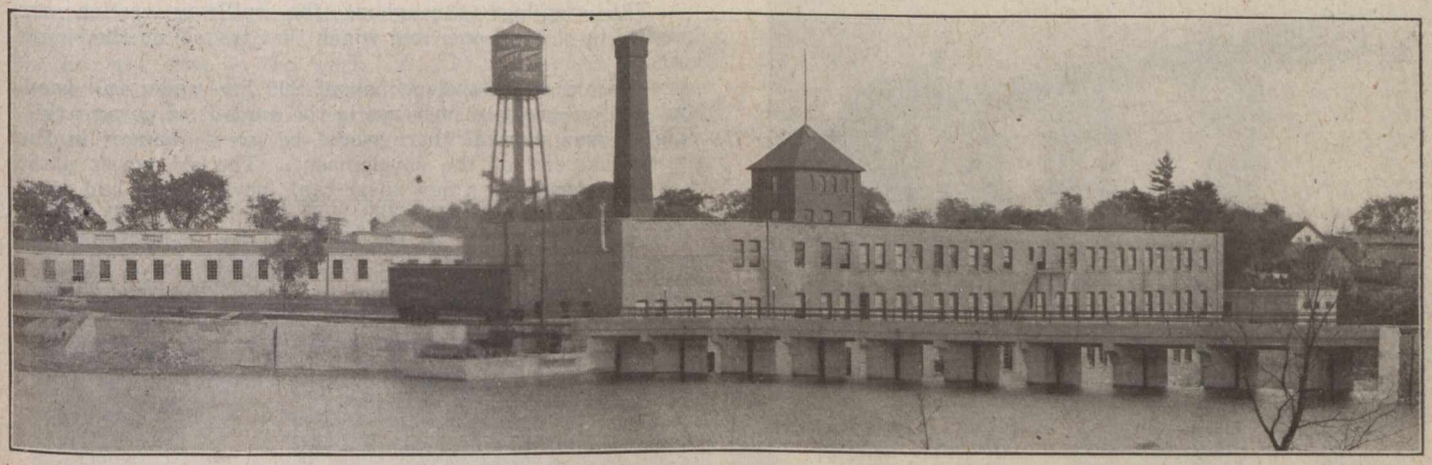


FIG. 1—CANADIAN CONSOLIDATED RUBBER CO.'S "DOMINION PLANT" AND ST. JEROME DAM—VIEW FROM UPSTREAM

Hydro-Electric Development at St. Jerome, Que.

Concrete Dam, with 190-ft. Spillway, Carries Railway Siding—Shaft of Hydraulic Turbine Direct Connected to Generator and also Drives Main Power Shaft of Factory By Means of Speed-Reducing Silent Chain

By L. A. WRIGHT

Assistant Engineer, The Foundation Co., Ltd., Montreal

WHEN last spring's floods carried away a portion of the old rock-filled crib dam used to develop power for the Dominion factory of the Canadian Consolidated Rubber Co., Ltd., at St. Jerome, Que., thereby reducing the power to such an extent that it was impossible for the factory to operate continuously, the company immediately decided that the condition and limited power of the old dam did not justify the expenditure of sufficient money to restore it to working condition, and that a new and larger dam should be built.

In order to secure the head of water that was desired for the new scheme, a water-power right further up the river had to be purchased, as it was flooded by the new water level. Arrangements had to be made also with some of the land-owners upstream, as a portion of their property was inundated.

Diamond drill borings were taken in June to ascertain the location and nature of the rock in the river. It was found that the whole river bed was covered with large boulders and a small amount of clay and gravel, and that the bed-rock was approximately 5 ft. below water level at that season of the year.

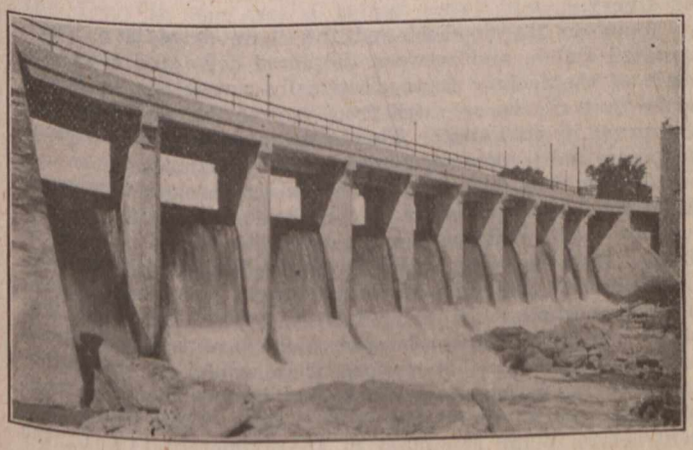


FIG. 2—A CLOSER VIEW OF THE DAM

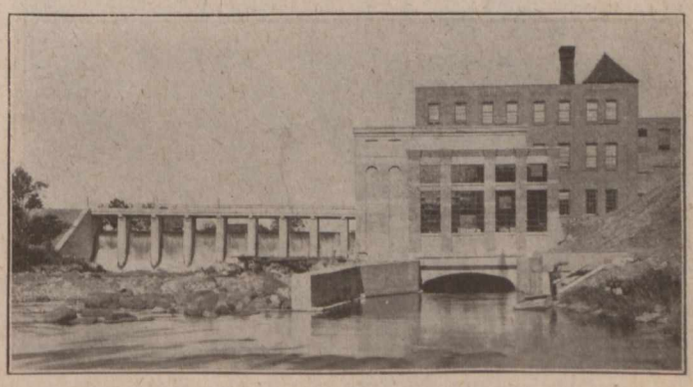


FIG. 3—LOOKING UPSTREAM—TAILRACE, POWER HOUSE AND SURGE TANK IN FOREGROUND; PART OF DAM IN BACKGROUND AT LEFT

The new dam is not remarkable nor were the construction conditions particularly unfavorable, but there were a few features of both design and construction that were somewhat unusual and should be worthy of comment.

The new dam is located approximately 20 ft. below the old dam and was designed for the development of 800 h.p. It is of the stop-log type, with piers 4 ft. thick, at 18-ft. centres. Allowance was made for a height of 10 ft. of stop-logs, effecting a 28-ft. head. The whole undertaking contained about 8,500 cu. yds. of concrete. The spillway, which is divided by the piers into ten sections, is about 190 ft. long, but with the coal pockets, and earth embankments on

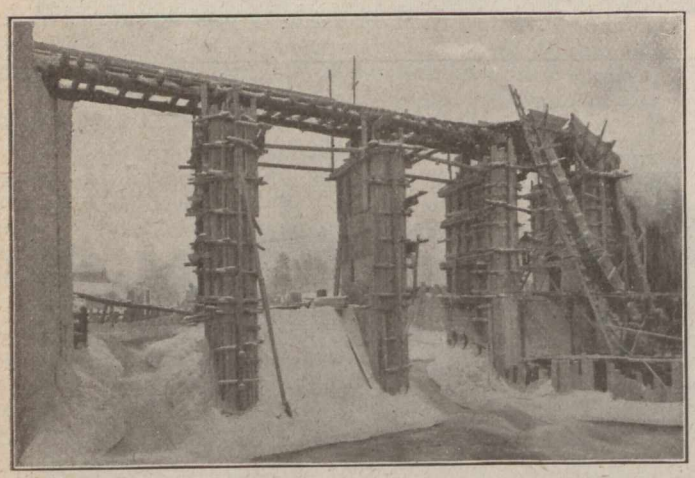


FIG. 4—THESE SECTIONS WERE LEFT OPEN DURING CONSTRUCTION OF REMAINDER OF DAM

each end, the overall dimension of the dam is about 580 ft. A typical cross-section through a spillway is shown in Fig. 6.

The unusual features in the design were in no way related to the development of power, but were principally due to the geographical location of the industry. The factory is on the east side of North river and had never had any railway connection. The C.P.R. was too far away and on the opposite side of the town. The C.N.R. was only about one-third of a mile away, but on the other side of the river, and a siding was never considered to be of sufficient value to warrant the expenditure for a bridge. The new dam was designed to carry a railway siding from the C.N.R. This

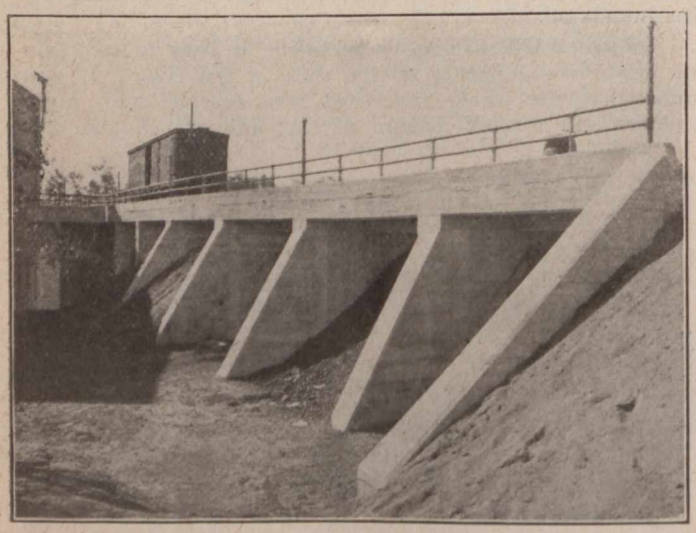


FIG. 5—COAL POCKETS IN CUT-OFF WALL

meant that the deck of the dam had to be 7 ft. higher than would otherwise have been necessary, in order to get proper grades, and had to be widened considerably.

Further widening of the dam was ordered so that a highway for pedestrians could be provided. The nearest bridge by which the company's employees could cross the river necessitated a detour of about half a mile, so that this feature of the design was much appreciated. Because of these conditions, the design of the deck of course is much different from the usual structures. It is quite possible that considerable benefit may be derived by the town due to the fact that the C. N. R. now has access to both sides of the river.

The concrete cut-off wall at the east end of the dam is supported by buttresses instead of by earth fill, thus providing coal pockets under the deck and adjacent to the boiler room. These are shown in Fig. 5. The coal is required for heating purposes in connection with some of the manufacturing processes and also makes it possible to operate the old steam plant should it ever become necessary.

The .stop-logs throughout the spillway section are handled by a hand-operated winch that travels on the siding rails.

The old dam developed about 200 h.p. under full head, and with so great an increase in the amount of power available, it was natural there would be great changes in the mechanical end of the development. The old power plant was abandoned and a new surge tank, power house and drive room were constructed. The surge tank is 290 ft. downstream from the face of the dam and the water is carried to it by an 8-ft. diameter steel penstock. The surge tank is 39 ft. long by 13 ft. 6 ins. wide by 25 ft. high, and is reinforced concrete construction. A horizontal double-runner hydraulic turbine was placed inside the tank, with its shaft projecting on one side into the power house and on the other into the drive room.

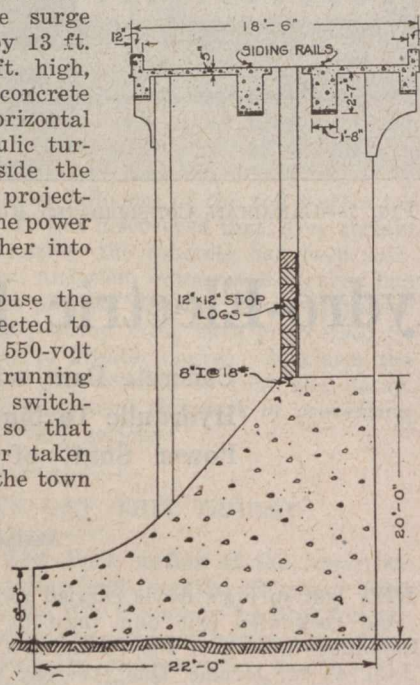


FIG. 6—TYPICAL CROSS-SECTION THROUGH DAM

In the power house the shaft is direct-connected to a 3-phase 60-cycle 550-volt 312-k.v.a. generator, running at 250 r.p.m. The switchboard is arranged so that power can be either taken from or supplied to the town of St. Jerome.

In the drive room the turbine shaft is connected through a 500-h.p. silent chain drive to the main power shaft of the factory. This drive reduces the speed from 250 to 75 r.p.m. The main shaft drives all the rubber-refining machines and provides for the principal power requirements of the whole factory.

On the turbine shaft, close to where it protrudes from the surge tank, is a 10-ton cast-iron flywheel, which was necessary, in addition to the turbine governor, to overcome the great variations in load caused by rubber-refining machinery.

Between the flywheel and the chain drive is a hand-operated clutch, and between the chain drive and the main shaft of the factory is an electrically-controlled clutch and brake that can be operated from any of the machines that are driven by that shaft. This brake is solely for emergency purposes, and is very successful in its operation.

The outflow from the turbine passes through a concrete draft tube under the floor of the power house and into the tailrace. The tailrace runs parallel to the river and is divided from the river by a retaining wall about 100 ft. long.

In order that full advantage might be taken of low-water conditions that existed at the time the work was started, a rather comprehensive plant layout was supplied by the contractor. Operations were going on simultaneously on all parts of the work, and it was necessary that an abundance of machinery be available. The value of the contractor's plant amounted to approximately 14% of the value of the work covered by the contract.

Operations were controlled to a very large extent by the fact that all materials had to go in over the railway siding, and on that account it was economical to work from the west side of the river, notwithstanding the fact that the bulk of the concrete was required on the other side. If railway connections could have been established on the east side of the river, much of the re-handling of concrete and long hauling would have been done away with.

Work was started on the west side of the dam after the railway siding had been laid up to that point. The earth embankment, with its concrete core wall, and the west abutment were the first items completed. The siding was then advanced along the fill so that cars of material could be brought close to the work. A stiff-leg derrick was set up on one side of the siding, and the mixer—with its storage and measuring hoppers—on the other side, where it could be easily reached by the derrick. All materials went in by

FIG. 7—DAM UNDER CONSTRUCTION—PART OF MIXING PLANT AT EXTREME LEFT—TRESTLE TO POWER HOUSE IN LEFT FOREGROUND

railway, and the sand and stone were unloaded by the derrick and a clamshell bucket. This derrick handled nothing but concrete materials.

A narrow-gauge track, for the operation of the flat car that carried the concrete, was laid from the mixer to the west abutment. At the same time the cleaning of the river bed and cofferdamming were commenced at the west end of the dam. Flash-boards had been erected along the west end of the old dam so that the water was diverted from that side when the cofferdamming was started. Novel and economical cofferdamming methods were developed for the work, the cofferdams being made of concrete and incorporated in the dam itself, thus effecting a great saving in cost and time.

The cofferdams when pumped out proved to be very free from water and the remainder of the footing was placed in the dry. In one case a rather heavy "geyser" was encountered, but it was led off in a 12-in. pipe, so it did not interfere with the concrete.

This method of cofferdamming has many advantages, any one of which fully justifies its use. Not only does it save time and material, but it also makes a better job. As each cofferdam was completed and the footing poured, work was proceeded with on the upper sections of the dam. Three sections were left open at different points in order to take care of the water that came down the river. These were afterwards closed by forcing a heavy 12 by 12-ft. frame-work down the piers, over the opening, and sheeting it in place. This dried the section and allowed the remainder of the work to be finished in the dry.

Much of the concrete work was done in severe winter weather, and precautions had to be taken to prevent damage by frost. Warm water was used in the mixer, and the sand and stone were heated in the usual way by steam lines passing through the storage piles. Over and around the portion of the dam that was being concreted, there was built a light frame-work from which tarpaulins were hung. Live steam was kept in and around this rouse for a sufficient time to prevent any damage. These precautions retarded the work somewhat, but they proved effective; practically none of the concrete was damaged. A 90-h.p. locomotive boiler was reserved simply for the supply of steam for this purpose.

As the dam progressed across the river, the narrow-gauge track from the mixer was extended with it. In the pouring of the deck, the concrete was handled in a steel side-dump car which dropped the material right where it was required.

The power house site was unwatered by practically the same method that was used for the dam. In this case, however, only one wall was necessary, as the mill building and the river bank formed the other sides. The site was pumped out and the excavation of gravel and large boulders was made with the aid of two guy derricks. When bed-rock was uncovered, the rock drills were put to work and sufficient rock was removed to allow for the draft tube. The draft tube was set and the concrete of the surge tank floor poured around it.

These buildings were on the opposite side of the river from the concrete plant and about 300 ft. downstream from it. In order to get the concrete to them, a light low timber trestle was built diagonally across the river. The concrete was dumped from the car on the deck of the dam to a bottom-dump bucket on a flat car on the low trestle. The trestle sloped downstream, so the loaded car travelled by gravity; a single-drum hoisting engine pulled the car upgrade.

At its destination the bucket of concrete was picked off the car by a derrick and carried to whatever part of the work it was required. Two buckets were used so that while one was being emptied, the other was going for another load. For many parts of the work the buckets had to be passed from one derrick to the other. Over 3,000 cu. yds. of concrete had to be poured in this section, so it was necessary therefore that the handling methods should be rapid and efficient in spite of the awkward location of the buildings.

The surge tank walls were 4 ft. thick and had to be waterproof; considerable care was taken, therefore, with the form-work and the pouring. For the forms 2-in. dressed lumber was used, and 4 by 6-in. lumber for the studs. Forms were built with the boards vertical instead of horizontal, so that better spading could be done. The results fully justified the method.

A protecting wall was built against the river bank so that the tailrace waters would not scour it away. When this was finished, the whole tailrace was dredged with clam-

shell buckets operated from the derricks. The material excavated was cast over the retaining wall into the river.

The engineers in charge of the work were T. Pringle & Sons, Ltd., Montreal, and the contractors for the diamond-drill borings and the construction were the Foundation Co., Ltd., Montreal. The water wheel and stop-log winches were supplied by the William Hamilton Co., Ltd., Peterborough, Ont., and the Canadian General Electric Co., Ltd., supplied the electrical equipment.

TO SPEND $4,500,000 ON WATER WORKS IMPROVEMENTS IN MONTREAL

RECOMMENDATIONS have been made to the city council of Montreal by the Administrative Commission of that city, that $4,500,000 be borrowed and devoted to water works improvements. The commissioners desire to complete the aqueduct, for water supply purposes, at an estimated cost of $1,683,000; to build a new low-level pumping plant, costing $850,000; and to increase the capacity of the filtration plant to 120,000,000 gals. a day, this extension to cost approximately $2,000,000.

The new low-level pumps are to be electrically driven, operating on power purchased from the Montreal Light, Heat & Power Co. It is proposed eventually to sell the equipment of the present steam pumping plant.

The estimate of $1,683,000 for the completion of the aqueduct includes the sub-structures of four bridges over the canal. The estimate of $850,000 for the new pumping plant provides for the installation of five pumping units, each having 30,000,000 gals. daily capacity.

The consulting engineers have calculated the cost of a new elevated reservoir, the construction of which they recommended, at $15,000 per 1,000,000-gals. capacity, and advise that the bigger the reservoir, the better. The commission do not intend to proceed at present with the construction of this reservoir.

The legislature of Quebec some time ago authorized the expenditure of $11,000,000 for aqueduct improvements, and there is a balance of $4,800,000 of this authorization which has not been used.

The commissioners submitted their proposed expenditures to the city council at a special meeting held last Thursday, and it is understood that the aldermen expressed their approval. Mayor Martin has written to the commission stating that the proposed expenditure is justified in order to obtain an adequate supply of water.

R. S. Lea, consulting engineer, attended the meeting and stated that with the completion of the aqueduct, Montreal would have readily available a water supply large enough for a city three times the size of New York. Questioned regarding the possibility of getting water from the Laurentian mountains, Mr. Lea replied that the scheme would be too expensive.

Mortimer Lamb, secretary of the Canadian Mining Institute, appeared before the private bills committee of the British Columbia legislature, February 26th, and opposed the legislation being sought by members of the Engineering Institute of Canada. Mr. Lamb said that the bill as drafted would not be in the best interests of the mining industry, and he claimed that several of its clauses should be amended before the bill is adopted. Mr. Lamb requested that the bill be laid over for one year.

The city council of Toronto have refused to build this year the new 20,000,000-gal. reservoir at Toronto Island. Works Commissioner Harris has requested reconsideration, pointing out that the rated daily capacity of the filters is 100,000,000 gals., but that their actual capacity is only 75,000,000 gals., and that Toronto's daily consumption is over 70,000,000 gals., and at times during the summer the consumption for a short period reaches a rate of 104,000,000 gals. a day. Unless storage for filtered water is provided, states the commissioner, it is certain that some unfiltered water will have to be pumped during the coming summer.

MANITOBA'S ROAD AND BRIDGE PROGRAM

TENDERS for grading about 800 miles of roads will be called for in Manitoba within the next two months, according to information supplied by the Good Roads Department of that province. This work will be let in contracts of from 2 to 75 miles. The work will be done under "The Good Roads Act," which has been in successful operation in Manitoba for the past six years. Up to the present, about 1,200 miles of work have been graded and about 400 miles gravelled under the Act.

In addition to the road work, it is expected that over 100 concrete bridges will be constructed. The bridge work will include a steel bridge 650 ft. long over the Red river; a concrete arch, 100 ft. clear span, over the La Salle river; several bridges of concrete over the Assiniboine river, and a number of bridges of from 30 to 50 ft. clear span. To date, 384 bridges have been built under "The Good Roads Act," of which 271 are concrete.

It is expected that over 4,000 miles of grading will be done in Manitoba within the next four years, and a large percentage of this mileage is to be gravelled. Under "The Good Roads Act," all work is let by contract.

The Canadian Pacific railway has accepted the offer of the Quebec government to subsidize extension of its Kipawa branch northward along Lake Temiskaming. The proposed extension is to be 76 miles long and will serve valuable agricultural, pulpwood and mineral areas. It is understood that the branch may be extended to Iroquois Falls.

One hundred draughtsmen in the employ of Toronto architects and engineers met last week in the Sons of England Hall, Toronto, to discuss the proposed formation of a trade union. After a lengthy debate, following addresses by organizers connected with the District Trades and Labor Council, the draughtsmen voted in favor of forming a union.

A typographical error has been noted in the advertisement which appears on page 54 of this issue, calling for tenders for power plant equipment and construction for the Nova Scotia Power Commission. It was intended that this advertisement should be jointly signed by the Nova Scotia Power Commission, of which Mr. Armstrong is chairman and Mr. Smith secretary, and by their consulting engineers, C. H. & P. H. Mitchell, of Toronto. Messrs. Armstrong and Smith have no connection with the firm of C. H. & P. H. Mitchell, as might be inferred from the incorrect typographical arrangement of the signature of the advertisement.

The following official statement has been issued by F. C. Biggs, minister of highways for Ontario, and W. A. McLean, deputy minister: "The development of roads under the provincial highway department is broad in scope and based on efficient co-operation with municipal councils. Aid is proposed to all township roads, supplementing ordinary township expenditure, which aid it is expected will become effective this year. Increased encouragement is to be given to the employment of permanent, working, township road superintendents, who, by experience as continuous as that of a township clerk or treasurer, can do much to systematize township road improvement. County roads, 9,500 miles in extent, comprising the leading roads radiating from market towns and shipping points, are given substantial encouragement through grants to county councils, 40% or 60%, according to the importance and traffic on the road. Provincial highways, comprising 1,800 miles, will be extended into every county, to which continuous maintenance will be given, and construction will be provided in accordance with the needs of traffic. The cost of building and maintaining roads is in proportion to the traffic over them. Provincial highways relieve county councils of the roads of heaviest expenditure. County roads relieve township councils of their roads of greatest cost. Township councils will receive supplementary aid for the remaining township roads. The system is one which extends needed aid to the improvement of all roads."

SOME NOTES ON POWER PRODUCTION*

By James White
Deputy Head, Commission of Conservation, Ottawa

In Canada the total developed water-power is about 2,400,000 h.p., and the total available power in the populated area of the country is estimated at less than 10,000,000 h.p. If development continued in the future at the same rate as during the last 10 years, we might look forward to the utilization of the whole amount before long; but, on the other hand, the powers offering the cheapest development per horse-power, the most remunerative markets, and, speaking generally, the maximum of advantage, are usually developed first. Thus, unless a new market is developed, a power developed at a later date near important markets is forced to compete with competitors who are well entrenched, and who, frequently, are operating under more advantageous conditions than the newcomer.

Moreover, the steam plant, as compared with the hydro-electric, occupies to-day a much more advantageous position than it did, say, 15 years ago. The hydro-electric plant had a high initial efficiency, and, in that period, has only made an advance of, say, 10%; in addition, it has reached such a high efficiency that it is not susceptible of considerable improvement. Its capital cost has increased, owing to the increased cost of labor and materials. On the other hand, the initial low efficiency of the steam plant offered ample scope for improvement, and the lower first cost is due to the development of the steam turbine; it is also susceptible of further improvement, and that improvement may be confidently anticipated. Though costs have risen since 1915, at that date the capital cost of the steam plant was only one-half what it was 15 years earlier. In addition, the consumption of coal in the steam plant has been reduced by from one-third to one-half.

May Expect Slowing Down

Thus, unless under exceptional circumstances, such as the great powers of the Niagara and the St. Lawrence, which have inherent advantages, we may reasonably expect in the future there will be a slowing down in water-power development except when carried out on an extensive scale by the federal or provincial governments as, for example, on the St. Lawrence.

The original application, during the parliamentary session of 1909-10, for permission to develop the Long Sault rapids of the St. Lawrence, was made by a subsidiary of the Aluminum Co. of America, which has a monopoly of the manufacture of aluminum in the United States and Canada. The applicants stated that they intended to use the power in the manufacture of aluminum, and that they would develop 600,000 h.p., an amount not much less than then developed at Niagara Falls. On the other hand, a survey of the available markets indicated that the applicant company was really looking forward to the development of the electric art which would permit economic transmission to New York, Newark, Jersey City, Hoboken and other cities in that vicinity.

The opposition of the Commission of Conservation to the granting of this franchise prevented the alienation of this valuable national asset, which will now, in all probability, be developed for the benefit of the citizens of Canada and of the United States.

At the Industrial Congress in Calgary in August last, the writer stated that a survey of the situation showed that in Alberta, for the development and transmission of power on a large scale, the generation of electric energy by great carbo-electric units (that is, steam generated from coal) of 20,000 to 50,000 h.p. each in super-power stations, presented the maximum of advantage. This conclusion was based upon the assumption that the electric energy be generated from low-grade coals which it would not pay to ship, that the power stations be constructed near large mines, and that there be an abundant water supply for condensing purposes.

In Great Britain, the power section of the Coal Conservation Committee has recommended that the country be divided into 16 areas; that units of not less than 20,000 h.p. be used, and in the largest stations units of 50,000 h.p.; that the plants be constructed at the pit-head if a very inferior coal is to be used, or near a river or estuary where condensation facilities are best.

As an example of electrical distribution, Dr. W. A. Bone cites Greater London, with an area of 693 square miles and a population of 7¼ millions. In it there are 65 separate authorities supplying electric energy upon 49 different systems from 70 generating stations containing 585 engines, and distributed at 24 different voltages to the consumers, who are charged at one or another of 70 different rates. The average size of the generating units is only 843 h.p., and the average size of the generating stations is only 7,050 h.p.

Sunshine and the Tides

Much attention is being given the world over to the question of power production. In this connection, Sir Oliver Lodge has pointed out the serious disabilities connected with the development of power from such sources as sunshine and the tides. He says that he cannot regard "with hope the idea of merely converting it (sunshine) into low-temperature boiler-heat. The barrenness of the Sahara would be the only excuse for the extensive use of burning-glasses or mirrors, and it is, perhaps, the only kind of place where such an enterprise could rationally be contemplated. But then there are few parts of the Sahara where power is particularly wanted, and economy of transmission has a limit."

Respecting the utilization of the tides for the production of power, the late Lord Kelvin recognized the extreme slowness of tidal operation. He realized the vast size of the reservoir that would have to be filled and emptied every 12 hours, and the probability that the reclaimed land of the reservoir would be of more value than the power,—at least in any locality where the power was really wanted.

Sir Oliver Lodge suggests that, if a Dreadnought were attached by a long girder to rack-work machinery and hoisted up and down by the waves, it would give many foot-tons per minute, but he doubted whether any machinery would stand the strain. He says that the idea is probably absurd, but that it seems less problematical than the harnessing of the tides.

In his presidential address to the British Association, Sir Charles Parsons said:—

To Harness Atomic Energy?

"The nations who have exerted the most influence in the war have been those who have developed to the greatest extent their resources, their manufactures, and their commerce. As in the war, so in the civilization of mankind. But, viewing the present trend of developments in harnessing water-power and using up the fuel resources of the world for the use and convenience of man, one cannot but realize that, failing new and unexpected discoveries in science, such as the harnessing of the latest atomic and molecular energy in matter, as foreshadowed by Clerk, Maxwell, Kelvin, Rutherford and others, the great position of England cannot be maintained for an indefiinte period. At some time, more or less remote—long before the exhaustion of our coal—the population will gradually migrate to those countries where the natural sources of energy are the most abundant."

In 1904, Sir Charles Parsons suggested that borings be sunk in the earth to sufficient depth to permit industry to utilize the heat existing below the earth's surface. He suggested that a shaft be sunk to a depth of 12 miles. The estimated cost was about $25,000,000, and the time required for the work 85 years. Since then, bore-holes at Lardello, Italy, have been made which discharge large volumes of high-pressure steam which is used to generate 10,000 h.p.

The report of the Minister of Public Works of Canada for the fiscal year ended March 31st, 1919, has been tabled in the House of Commons, and shows a total expenditure of $21,395,500, of which $8,492,502 was charged to war accounts.

*Excerpt from address at the recent annual meeting of the Commission of Conservation.

REVIEW OF ROAD LEGISLATION IN ONTARIO*

By K. W. McKay
St. Thomas, Ont.

SINCE the organization of the Ontario Good Roads Association, 26 years ago, there have been some remarkable changes in public opinion. The advent of bicycles and the propaganda fostered by their progressive owners, created a spirit of unrest and a demand for larger expenditures for the improvement of highways. There was considerable opposition from rural municipalities in which the time-honored compulsory system of statute labor had been in force since its introduction by the first settlers. The bicycle was a constant source of annoyance. It disturbed those travelling on the highway with uneducated horses, the result being that the new means of transportation was largely confined to special paths on the roadside.

The formation of the Ontario Good Roads Association in 1894 was a response to a demand for a proper consideration of the whole question of highway improvement. An active educational campaign was inaugurated, followed by the appointment of a provincial highway commissioner who devoted his whole time to the work. The press of the province was of the greatest assistance. Public meetings were held throughout the province.

Another "Pest" Introduced

The statute labor system was attacked, and the use of machinery for road construction advocated. In the meantime the objections to the bicycle were forgotten. Expression was given to an educated public opinion in 1901, when the Highway Improvement Act was passed and $1,000,000 appropriated for the improvement of roads designated by county councils.

About this time another road pest known as the automobile was introduced. It was not safe to drive on roads frequented by them. The association's delegates in 1906 discussed at length the difficulties arising therefrom, and unanimously favored the restriction of motor traffic. The act to regulate and license motor vehicles was passed the same year. The motor car has since proved to be a blessing in disguise. It has supplanted the family horse, and revolutionized highway transportation generally.

The operation of the Highway Improvement Act was gradually extended, and in 1913 the demand for better roads was so great that a commission was appointed to consider the whole question. Their report was presented in 1914, and as a result we now have a Department of Public Highways, provincial county roads, suburban areas and increased provincial subsidies.

The provincial highway idea was adopted in 1917; and when federal aid was granted in 1919, the highest anticipation of the originators of the movement for better highways was apparently realized.

Expenditures Will Exceed $8,300,000

Ten thousand miles of road have been assumed by the county councils, of which 233 miles are included in suburban areas. The estimated provincial subsidies payable for 1919 amount to $2,300,000, and the expenditure on all classes of highways—township, county and provincial—will exceed $8,300,000. The once despised automobile is an important factor in highway improvement.

The number of motor licenses issued during 1919 was 144,804, being an increase of 30,500, or 26%, over the previous year. Of these licenses, 47% were issued to residents of cities, the remaining 53% being distributed throughout the other districts of the province. The fees collected amounted to $1,580,105. With such a progressive source of revenue, the financing of subsidies for improved highways would appear to be on a safe foundation.

*Address of the retiring president at the 18th annual meeting of the Ontario Good Roads Association, March 3rd-5th, Toronto, Ont.

The trend of all public legislation should be towards the equalization of opportunity and expense. In Ontario the legislature has kept this in view. One matter that should receive immediate consideration is the advisability of imposing a direct assessment for benefit.

Highways are naturally classified by the amount of travel thereon, the most expensive roads being constructed where the traffic is greatest. The improvement of any highway has the effect of increasing land values in proportion to the expenditure necessary to provide a road sufficient to accommodate the traffic over it. When a county road is constructed, it is generally of a higher standard than the average township road, and the benefits derived by the district in which it is located is proportionately greater. Property values are largely influenced by improved transportation facilities, be they in the form of steam railways, electric lines or well built roads. When a county completes a system of roads under the provisions of the Highway Improvement Act, the value of the property is increased because local transportation facilities are improved. The townships in which the roads are located are relieved of the care of many of the more important highways and the citizens generally derive a direct benefit from this, as well as from the improved means of transportation in their midst.

The present legislation appears to be lacking in two respects if perfect equalization is desired. Townships in which provincial highways or county roads are located should be required to make a direct contribution towards the cost of construction and maintenance, and the councils should have the right of shifting their liability to the property-owners benefited by the construction of the roads. That public improvement does increase the value of land is well recognized, but there is no hard and fast plan for determining the benefit derived. This can only be fixed after each individual case has been considered by an engineer competent to report thereon. To enable this to be carried out, each township should be looked upon as a construction area in so far as roads located therein are concerned, and their contribution to the cost of the roads limited to from 20 to 30%.

Administration of Assessment Law

If a township council decides that the man living on a back concession should pay the same rate of taxation as the man living on an improved highway, whose property has been largely increased in value thereby, the question of assessment for benefit may be eliminated. If the council decides that the land-owners fronting on or contiguous to the road should make direct contribution towards the cost of construction, the procedure laid down in the Drainage Act should then be applied for the apportionment of the cost payable by the township amongst the land-owners benefited. There is considerable difference between a frontage rate and assessment for benefit, for there are properties that would derive little or no benefit whatever from the construction of an improved highway.

The Ontario Highway Commission made a comprehensive report on the effect of good roads in raising land values and the necessity for a proper assessment. From information before the executive of this association last year, the assessors' valuations of land along the Toronto-Hamilton Highway in at least one township were shown to be less than they were before the highway was constructed, and that sales had been made at very considerable increases over these values. The Highways Department should procure a report on actual conditions in different parts of the province, with a view to having the assessment law properly administered.

The Highway Improvement Act

The Highway Improvement Act is a very complete piece of legislation. There is, however, one matter the Highways Department should consider, and that is the necessity for some supervision of debenture issues for road expenditures. In paying for road improvement, three systems are available: (1) By annual levy; (2) by a combination of annual levy; and (3) by debentures issue for the whole cost.

The provision of the Act providing for the issue of debentures for any expenditure and limiting the debenture

term to 30 years is too general. The department should insist that this be limited to the estimated lifetime of the work and the maintenance system to be inaugurated. It is not good financing to extend the debenture term so that a road will be worn out and reconstructed before the first debenture is wholly paid. The supervision of debenture issues by the department is suggested.

Civil Liability

The general use of motor vehicles and changed traffic conditions is directing attention to the provisions of the Municipal Act, Section 460, which reads as follows:—

"Every highway and every bridge shall be kept in repair by the Corporation the Council of which has jurisdiction over it, or upon the duty of repairing it is imposed by this Act, and in case of default, the Council shall be liable for all damages sustained by any persons by reason of such default."

The Act making the municipalities liable was introduced in 1850 with reference to roads in cities and towns, and in 1859 was included in the Municipal Act. The control over the highways of the province was then in a transitory state. Municipal institutions were in their infancy and it was thought that the councils would not be able to maintain the roads. This resulted in the formation of great many toll road companies to take charge of the main highways, which had been or were still in some cases under the control of the Minister of Public Works, and to relieve municipalities of liability for non-repair.

There appears to have been some misunderstanding in reference to precedents for the section making municipalities liable. It was, no doubt, copied from the laws of one of the United States, and afterwards looked upon as being in accordance with English law. The late Mr. Biggar, in his Municipal Manual, remarks in this connection that "the common law obligation of parishes in England to repair their highways did not involve the existence of a civil liability to pay. One sustaining injury owing to the non-repair of a road can sue the municipality only if the Legislature gives him a right of action."

Present Law Unsatisfactory

There can be no question but that the law respecting actions against municipal corporations for damages caused by the non-repair of highways is in a very unsatisfactory state. It is submitted that a municipality should not be held liable for defects in highways unless the defect is of its own direct creation, and that Section 460 should be amended by eliminating the words imposing a civil liability.

No such liability has been imposed by statute in any other of the provinces of Canada except the province of Manitoba, and in the case of that province there is the following provision: "Provided, however, that the liability of such corporation shall be limited to the portion of the road on which work has been performed or public improvements made by the municipality."

To Discuss Liability Again

In Ontario, the liability to repair extends to the whole width of the highway, and so strictly are municipalities dealt with that practically every person using the highway is insured against accident. The matter has been brought to the attention of the legislature many times during the past fifteen years by provincial deputations and by this association in co-operation with the Ontario Municipal Association.

In 1912 a bill was introduced in the legislature by Mr. Ellis, of Ottawa, who is now director of the Bureau of Municipal Affairs. It was supported by the late Mr. Hanna, provincial secretary, but met with very strong opposition from both sides of the House and was thrown out in committee. The question is to be discussed again with a view to having it formally considered by the new regime.

Some municipalities have adopted the plan of taking out indemnity policies protecting them from personal and property liability resulting from accidents on highways under their control. This is to some extent an innovation, but as long as the premium charges are reasonable, it is a business-like proposition, the same as insurance for any other purpose.

It has been announced in the press that some measure of provincial aid will be extended to townships for road improvement. This should be granted in a way that will encourage township councils to be progressive, to appoint township commissioners and to inaugurate the systematic use of split log drags with a view to keeping all the roads good all the time.

NEW 18,000 K.V.A. HYDRO-ELECTRIC DEVELOPMENT

Abitibi Power and Paper Co. Have Started Construction of Concrete Dam and Power House at Twin Falls on Abitibi River—Will Require 80,000 Cu. Yds. of Concrete

By H. L. Trotter
Engineer for Morrow & Beatty, Ltd., Iroquois Falls, Ont.

WORK on the new power development for the Abitibi Power & Paper Co. was started last month. The site of the new plant is at Twin Falls, on the Abitibi river, about eight miles above Iroquois Falls. Power will be transmitted at 23,500 volts to the paper mill at Iroquois Falls.

The development involves the construction of a power house and concrete dam, with core walls at each wing. The dam will be of solid concrete and will raise the head water 58 ft., giving a normal operating head of 60 ft. The head water will be raised to the level of Abitibi lake, drowning out all rapids and falls between Twin Falls and the lake.

The power house will have four units, each consisting of a 4,500 k.v.a. generator coupled to a single-runner hydraulic turbine on a vertical shaft. The draft tubes and scroll cases will be moulded in concrete.

The total quantity of concrete in the work will be about 80,000 cu. yds.

The electrical equipment will be supplied by the Canadian Westinghouse Co., Ltd., and the turbines and governors by the I. P. Morris Co., Philadelphia, Pa.

Supplies are being hauled to the site over a snow road from Iroquois Falls, but when the river opens, supplies will come in by scow, via the Black river and Abitibi river, from Matheson on the Temiskaming and Northern Ontario railway.

The general contractors for the work are Morrow & Beatty, Ltd., Peterborough Ont., who built the Abitibi Power & Paper Co.'s original power plant and paper mill at Iroquois Falls. T. A. Barnett, formerly one of the superintendents on the staff of the Hydro-Electric Power Commission of Ontario, is general superintendent in charge of the work for the contractors. Plans, specifications and supervision are being supplied by Geo. F. Hardy, consulting engineer, New York City.

Patents have been issued to the National Iron Corporation, Ltd., Toronto, for water-cooled machines for moulding iron pipe by centrifugal force. Supplementary patents have also been issued for heat treatment of these centrifugally cast pipes. The inventors of these machines are D. S. de Lavaud and F. Arens, Jr.

The sessions of the seventh annual meeting of the Canadian Good Roads Association, which will be held June 1st-3rd in Winnipeg, will be in the banquet hall of the Royal Alexandra Hotel, while the exhibition will be in the "old ballroom," and will consist of samples of road materials, photographs, models of various types of roads, etc. Provision is also made for heavy exhibits in actual operation, consisting of road graders, drags, rollers, etc., which will be located on the property at the rear of the hotel. The first allotment of space is now being made, preference being given to applications in the order in which they were received. In the ballroom there is space for 25 exhibits, the sizes of the booths ranging from 50 to 150 sq. ft. in area and from $50 to $200 each in price.

THE SOILS OF THE GREAT PLAINS*

By D. B. Dowling
Geological Survey, Ottawa

If the surface of the earth were a part of a perfectly rigid sphere, the continents would probably have remained as groups of islands, with the lowlands composed of breccia and sand, while the material of which much of the soil is made would have been carried into the sea.

There is much direct evidence, however, which indicates repeated changes of level, showing a certain flexibility of the crust. To this we owe the submergence of large areas during which they received a coating of the rock waste carried into the sea. Much of this rock waste, by a shifting of load or other cause, is now elevated above sea level and underlies the great agricultural areas, so that we may say that the flexibility of the crust, by providing soil for the necessary plant growth, made possible the peopling of the earth other than around the fringe of the continents.

In the northern part, the existence of a soil does not depend altogether on this condition. The latest mantle of soil in most areas is due to the transportation of rock waste by the great continental ice sheet. This material is not, however, a soil-maker of as high grade as the water-borne rock deposited in lake or sea basins.

The plains of North America bear in their underlying rocks the record of long invasions of the sea and these form what seems to have been a very old feature in the history of the continent.

Early History Very Obscure

Much of the early history of North America is very obscure, but we know that at several periods the ocean encroached and almost submerged the continent. The maximum submergence was probably in Ordovician times, represented in Ottawa by the deposits of limestone beneath the city, the same limestones being beneath Kingston and Winnipeg. Later the seas encroaching on the continent became shallow, and the deposits instead of being mostly lime gave place to muds and sands. These were better soil-makers and their decay provided much of the soil for the plains of eastern America.

The western plains received a much later addition of soil-making material beneath a shallow muddy sea. Along the western border of this sea, the rocks were being crushed and ground in the early mountain-building which preceded the final upthrust of the Rocky mountains. Hundreds of feet of very fine grained material, now somewhat hardened to shale, covered the sandstones and limestones of the former plain, which stretched to the old mountains of central British Columbia. The muddy sea, being fairly shallow, was very susceptible to any differential elevation, and at one time, near its end as a sea, it was almost emptied as the water retreated toward the gulf of Mexico. The western border was apparently at all times a shifting one, for the muds are interspersed with wedges of sandy material which, by their extension eastward, show the approximate amount of the uplift of the western edge, for that is where the disturbance of the crust was mainly located. During these periods of tilting, forests and marshes crept eastward, the amount of entombed vegetable matter in the present coal seams marking the length of the intervals of quiet.

Last Addition to Plains

The latest addition towards the building of the plains, previous to the carving of the surface, consists of a mass of coarser grained material which is not definitely sea deposit, and marks not only the retreat of the sea but a nearer source of debris than the earlier muds and sands. This was evidently due to an elevation of the area now occupied by the Rocky mountains, which continued along with a general rise of the whole basin until its progress was halted when the areas under greater strain reached the limit of compression and the crust bent and broke along the folds. The breaks were repeated in parallel series, especially in the Canadian portion near the western edge, and formed the Rocky mountain structure. This was at first probably a very high ridge of very much broken and crushed soft rocks, mostly sandstones, clays and shales.

The carving of the plains then began, and the removal of the debris and the higher part revealed the hard limestone ridges of the present mountains, and the first phase of erosion might be said to include the planing of the slope from the mountains to the lowlands. Along this slope it is conceivable to suppose that much of the debris from the mountains might be scattered. As it was passed along, only the harder material would survive as gravel and boulders, well rounded and reduced in size before reaching the sea.

Second Cycle of Erosion

The top of the Cypress hills and the Hand hills are supposed to be remnants of the old slope, and there we find a great deposit of coarse conglomerate of late Tertiary age, pointing to the probable age of the uncovering of the Rocky mountains. With the removal during this first period of erosion of a vast quantity of material into the sea, probably to the northward, the relief from the load induced a further elevation, and a consequent second cycle of erosion resulted in the great scouring shown in the depression running from the vicinity of Lethbridge eastward, north of the Cypress hills, and in many of the great valleys through the foothills followed generally by the present rivers.

The coming of the glacial period and the movement of the great glacier over the plains altered the general surface slightly. It probably smoothed the surface somewhat. On the melting of the ice, the deposition of its load of clay and boulders and the diversion of streams around its edge, probably, did more toward altering the topography than any planing action that the mass of ice had exerted.

The occupation by the ice of the valleys down the slope toward the northeast, or rather the melting of the ice, which proceeded generally from the southwest, left a moving barrier which seemed to have preserved a northwest-southeast front across the plains. This, as it also provided a great supply of water, not only diverted the streams to the southeast, but by the great flow of water for short intervals, scoured new channels which in depth and area are comparable to the old valleys. Many lakes were formed along the ice front, and in these the rock debris from the melting ice was sifted out, forming to-day much of the fertile lands.

Ridges of Boulder Clay

Where the ice front paused for long periods, great ridges of boulder clay were left. These form a very irregular type of topography and can be traced readily. They are not of equal value as fertile areas with the more gently rolling lands where the surface covering was deposited in water, but from their irregularity provide more ponds for surface water and have a greater value as grazing lands. The most striking example of moraine topography is to be found in the Coteau and its continuation north of the Saskatchewan. It can be traced under different guises, such as sand hills and boulder-strewn hills, to the Buffalo park at Wainwright, and even farther toward the bend of the Athabaska.

Many of the channels cut during the period of retreat are still used and probably account for the peculiar southeast trend of many of our streams, although the direction of slope of the surface is to the northeast for most of Saskatchewan and Alberta. The streams that broke away and got into their old channels may include the two Saskatchewans and the Athabaska.

It is quite possible that the Athabaska for a time had to use the valley of Beaver river and Sturgeon river to Prince Albert, and it is pretty generally conceded that for a time the South Saskatchewan was diverted above the Elbow to the Missouri by way of the Old Wives, Willowbunch and Big Muddy lakes, and later by way of the Souris and Qu'Appelle to the lowlands of the Manitoba plain. These diversions nearly all came by way of impounded lakes in

*Paper read at the recent annual meeting of the Association of Dominion Land Surveyors.

the original valleys spilling along the ice front and the scouring of the great flood thus let loose, cutting channels which sometimes effected a complete change in the drainage. The old lake west of the Coteau was not long lived and did not complete its drainage channel. The outlet was shifted to east of the Coteau and the Regina plain became a lake basin which was drained to the south-east. Most of the outflow went by way of the Assiniboine and thus was formed the deep channel of the Qu'Appelle which finally drained the lake, leaving a large area of rich alluvium on the upland.

The melting of the ice in the lowlands of the Red river valley created there a long lake which was not as readily drained as were others to the west, since its natural outlet was to the north and was long occupied by the ice dam. For a time this basin spilled at its southern end in Minnesota at Lake Traverse. The outlet here was maintained by a general tipping of the surface; that is, the land rose slightly at the north as the ice load was removed, until other outlets were provided either through or around the ice toward Hudson bay. The surface then gradually fell and on the Manitoba plain its retreat is outlined by regular beaches now on dry land, the more prominent ones being on the eastern slope of the Manitoba escarpment. The Canadian National Railway from Gladstone northward along the foot of these hills is largely built along these natural embankments. Near Winnipeg, a good example of an island shoal in this lake is found in a beach on the top of Stony mountain.

Boulders Used in Saskatoon

The benefit of this old lake to the agricultural value of the land of the Red river valley can hardly be measured. At one period it attained a depth over the country around Winnipeg of 560 ft. and its waters received all the ground-up material obtained by the trenching of the valleys of the present Pembina, Assiniboine, Souris and Qu'Appelle rivers. This was deposited in the basin, most of it in the southern part, but the plains around Dauphin, Swan and Red Deer lakes also received a generous supply.

The question of the soils thus seems to be intimately connected with the history during glacial times. Much of the soil material carried forward in the ice was derived from the Cretaceous surface to the northeast, and the boulders from the Pre-Cambrian area beyond the Cretaceous terrace. Boulders carried by the ice from the vicinity of Cumberland lake are found near Saskatoon and have been used in the construction of the buildings of the University of Saskatchewan. The Manitoba plain is floored with the debris of the excavation of the valleys entering from the west.

PUBLICATIONS RECEIVED

WHITE LEAD: ITS USE IN PAINT.—By Alvah Horton Sabin. First edition, 1920, published by Jno. Wiley & Sons, Inc., New York; 134 pp., 5 by 7¼ ins., and folded tables of costs, etc.; cloth bound; price, $1.25.

RUNNING AND MAINTENANCE OF THE MARINE DIESEL ENGINE.—By John Lamb, chief engineer, British Mercantile Marine. Published by Chas. Griffin & Co., Ltd., London, Eng., 4 by 6½ ins., 230 pp.; frontispiece, plates and 106 illustrations; cloth cover; price 8s. 6d.

AMERICAN CIVIL ENGINEERS' HANDBOOK.—By Mansfield Merriman, editor-in-chief, and a board of eighteen associate editors; 4th edition, 1920; thoroughly revised and enlarged; published by Jno. Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, Eng.; 1,956 pages, 4½ by 7 ins., flexible binding; price $6.00. An appendix on colored paper gives Searles' mathematical tables. A new section by W. A. Del Mar is entirely devoted to electric railways, while another—by H. W. King—treats of irrigation and drainage. All other sections have been brought up-to-date, and in some cases have been rewritten and enlarged. This edition has nearly 400 more pages than the third edition. On account of the present size of the book, the name has been changed to "handbook" instead of "pocketbook."

TIME AND COST-KEEPING ON COUNTY ROADS*

BY K. W. MCKAY
Retiring President, Ontario Good Roads Association

IT is said that familiarity breeds contempt, and while comparisons are sometimes odious, it is desirable to have some idea of what road improvement and maintenance is costing in the various counties. From the municipal point of view, provincial subsidies cover up a lot of overcharges, extravagance and mismanagement.

The principle behind all of our municipal legislation is co-operation for the equalization of opportunity and expense. One of the first acts of the parliament of Upper Canada was in reference to statute labor, which is a compulsory system of co-operation in improving roads. This was followed by the toll-road idea, which became unpopular as soon as townships or municipal co-operative areas were established. The tendency in recent years has been to place more responsibility on the counties and the province. The recent grant of federal aid completes the utilization of the expense of highway improvement. Within the next few years, the populous centres of Canada (and Ontario in particular) will be participating in the benefits to be derived from high-class roads. A general demand will then arise for direct contributions from townships or property-owners benefited by the construction of improved highways to a greater extent than is now provided for.

Reasonable Comparison of Costs

County road expenditures are levied on the equalized values of the local municipalities. The county road superintendents have important duties to perform in the distribution of county levies and provincial subsidies. They should see that both the county and province gets value for moneys expended.

There should at all times be a reasonable comparison in the cost of similar work in different parts of a county, and reports to the provincial department should assist in comparing results throughout the province. Highway improvements is a large undertaking; county superintendents are entrusted with a greater responsibility than any other class of municipal officers. They must adopt every idea leading up to greater efficiency, if they are to retain the public confidence.

A cost system must be one that will appeal to the superintendent. It should not be too elaborate or intricate. Those who have had experience in other fields of work know the importance placed by large contractors on their cost system and the technical staff employed to maintain it.

A foundation for a uniform system of cost-keeping is desirable. The county roads should be divided into patrol districts, which should be subdivided into smaller construction sections, all to be numbered for reference. This classification of the road area should be entered in a suitable book with particulars as to location of culverts, bridges, hills, etc.

Experience suggests that county superintendents may not appreciate the importance of this record, and that the Highways Department should be interested to the extent of supplying uniform books to be completed in duplicate with the assistance of the inspecting engineer or an officer appointed for the purpose.

Weekly Reports from Foremen

As construction or maintenance work is performed, the superintendent should receive weekly reports from his foremen giving time and how employed, together with particulars that will enable him to determine the following:—

1. Cost per mile for scraping with road grader, split log drag or other implement.
2. Cost of gravel or stone per load delivered on a road, with source of supply, length of haul and wages paid.
3. Cost of weed-cutting.
4. Cost of cleaning ditches.

*Paper read at the recent conference of county engineers and road superintendents of Ontario.

In connection with the cost of culverts, the size, class of construction and depth of fill should be noted, and in addition—for bridges—the height above the stream and work on approaches.

In constructing roads, particulars as to grading, rate of wages, metalling, rolling per mile of road-bed or surface material, will be valuable.

Proper records of the labor and material utilized in oiling roads will popularize this efficient system of maintenance.

Railings should cost the same per rod in different parts of the county, and where the cost of tile drains differs, the particulars should be included.

The wear and tear on machinery forms an important overhead expense, and a record of first cost, maintenance and service will be most valuable in preparing estimates including renewals.

Excellent Check on Efficiency

A cost system is an excellent check on the efficiency of foremen. It is the ultimate test of good organization. It will enable a superintendent to meet criticism with facts, and maintain his position in submitting estimates.

It is not intended that all cost particulars be entered in the book above referred to; cards printed to suggest the information required should be used. These may be carried by the superintendent and kept in a card index in his office. The cost of permanent culverts, bridges and other work, when completed, should be entered in the book.

As already suggested, the foundation of a cost system is a proper report from the foreman in charge of the work. The form known as the Maintenance Foreman's Weekly Report will be more within the comprehension of the average patrol man, and may be substituted for the time-book or larger pay-sheet. When combined with the individual cheque system of payment and suitable voucher form, this will do much to assist in the business-like administration of road improvement expenditures. Last year it was expected that something would be done to secure more uniformity in county road bookkeeping. There is every necessity for this. The superintendents and treasurers all have ideas. A comprehensive report on the whole question should be available.

The formation of a western waterways association is being advocated by Mayor C. F. Gray, of Winnipeg, to encourage the development of waterways in the paririe provinces. As an example of what might be accomplished, says the mayor, the Saskatchewan river could be made navigable to permit the transportation of coal from western fields. This waterway, he points out, runs through an immense pulpwood area and a district which is rich enough in copper sulphite deposits to supply the whole continent with sulphuric acid.

Eighty officials and employees of Morris Knowles, Inc., consulting engineers, Pittsburgh, Pa., attended the annual banquet of that organization, held recently at the University Club, Pittsburgh. Mr. Knowles made brief mention of the first dinner of the organization, held in 1914 with 10 present. Messrs. Garvin and McDowell, associates of the late R. Winthrop Pratt, of Cleveland, were then presented and made short addresses. One of the principal features of the evening was the announcement by Mr. Knowles of arrangements for the consolidation of the organization of Morris Knowles, Inc., with that of the late R. Winthrop Pratt. The various branch offices established by each organization will be continued. Although both firms have done important work in connection with water supply projects, sewerage systems and drainage, Mr. Pratt's organization specialized in garbage and sewage disposal plants, sewerage systems and water works, while Morris Knowles, Inc., developed special departments of town planning, industrial housing, flood prevention, valuation and rate-making, and appraisals. This consolidation results in a personnel of 130, and places the organization among the largest consulting engineering firms of the United States.

DRAINAGE IN ROAD CONSTRUCTION*

By G. R. Marston
Engineer of Norfolk County, Ont.

IN road construction and maintenance, our first thoughts should be given to drainage. It is the first principle of road building. Many articles have been written in the scientific journals, and many papers read before road conventions, on drainage, but they have not yet penetrated deep enough into the minds of those in charge of roads, or else the latter have failed to impress this matter on those working on the roads. If drainage were carried out properly, there would be fewer mudholes in earth, sand-clay, gravel and water-bound macadam roads, and less foundation failure in bituminous macadam, asphaltic-concrete and brick roads, and fewer cracks in concrete roads. While there are road failures from other causes, poor drainage is the first cause. Water is the greatest natural enemy of all roads.

There is no set rule for draining a road. Each portion of the road will present its difficulties, and the road engineer's business is to overcome the difficulties and to devise the proper system to drain the road. The nature of the subsoil, the topographical features of the road itself, and those of the surrounding country, will be his chief guides.

Three Types of Drainage

Three types of drainage for roads present themselves: (1) To keep the water out of them; (2) to keep the water from alongside of them; and (3) to keep the water from under them. The first two of these propositions is accomplished by what is known as surface drainage and the third by subdrainage. Surface drainage is always necessary; subdrainage is needed in soils having no natural underdrainage.

The crown of the road, the side ditches or gutters, pipes and culverts, are the means which are resorted to in order to procure surface drainage. The height of the crown of a road necessary to drain an earth road is best found by experience. The usual crown is about an inch to the foot of width from the centre of the road to the side ditches, and this is usually increased as the longitudinal grade of the road increases. As heavy traffic soon ruts earth roads, it is necessary to use the road drags frequently to prevent the formation of deep ruts or the surface water will follow the ruts and the roads will suffer from washouts and erosion.

The side ditch and gutters are intended to carry off the water shed from the road by the crowns, and to keep the water from outside of the right-of-way from flowing into the road. These ditches should be dug to as uniform a grade as possible, and should be in good alignment and sufficiently wide to carry off the water, and about 2 ft. deep below the outer edge of the graded portion of the road. These ditches will carry the water to the smaller creeks or outlet drains. If there is no apparent outlet, one must be procured either by consent or by the application of the Ditches and Watercourses Act.

It is important that these side ditches and gutters be properly maintained or they may become choked and cause serious damage. When roads are constructed along hill-sides, it is often necessary to dig what is known as a secondary drain. This drain should be well up the side of the hill so that it will intercept and dispose of the larger amount of water before it has a chance to reach the regular ditches.

Permanent Surfaces Prevent Rutting

The penetration of earth, gravel and macadam roads by water has not altogether been solved by crowning of the roads, and for this reason many municipalities are constructing roads with more permanent surfaces, such as bituminous and concrete surfaces, which prevent rutting and the consequent action of water. There is no doubt that with increasing traffic, which means more rutted roads, these more per-

---

*Paper presented at the recent conference of county engineers and road superintendents of Ontario.

manent surfaces will become more popular, and while more expensive to construct, the decrease in maintenance will offset the increase in cost.

Subdrainage is required where the soil is so dense that the water lies in the ground and can be made dry only by drains placed under the ground deep enough to reach this water. The drains are intended to drain the subsoil only, and it is not intended that any surface drainage should be allowed to enter them. Underdrains lower the level of the water in the soil and thereby prevent the road surface from being disturbed by softening of the foundation.

Tile Replaces Older Drains

The older types of subdrains, such as the wooden box drain and drains built with flat stone, have been replaced in the present day by the use of tile. The layout of a subdrainage scheme depends upon the conditions found in the road to be drained. A study of the road should be made and inquiries made from old residents who have known the road for some time. The source and the amount of water should be determined, because this information, taken in conjunction with the grade which it is possible to give the tile, will determine the size of the tile required.

Tile should, as a rule, be laid on both sides of the road, but this may not always be necessary. Where the roadway is in a cut having a bank on one or both sides, the water will usually be found to come from these banks in the form of seepage or springs, and in these cases tile should be placed under the side ditch at the foot of the bank, which will prevent the water from passing under the roadway. Special attention should be given in grades, as springs frequently occur, and sometimes it is an advantage to cross-tap a road to prevent water seeping down the hill.

Care should be taken laying the tile. The trench should be dug in a straight line. The position of this trench must be determined by the road engineer. I am in favor, in ordinary cases, of placing the tile immediately under the shoulders of the road or slightly nearer the centre of the road than the side ditch. The tile should be laid true to grade. In shifting soil it may be necessary to lay the tile on inch-boards about four or five inches wide. This will ensure them against buckling, which often happens with tile laid in a quicksand bottom. The backfilling of the trench should be made with gravel or stone if possible.

Joints in Bad Soils

In bad soils it may be necessary to use a tar paper over the joints to prevent the silt entering the tile. Sawdust has been used very successfully for this purpose. Where the drains have a long run, catch basins should be used. These are used for inspection purposes; sediment will be trapped here if the bottom of the catch basin be constructed lower than the flow line of the tile. The bottom should be about 18 ins. below the tile. They also provide a vent to the drain. The outlets of all tile drains should be protected by concrete walls where the drains are deep, and by slabs placed over the tile where the tile is shallow.

While a great deal more may be said and written on the subject of drainage, it will be of no avail unless all persons engaged in road work be taught the benefits that a road derives from a good drainage system.

The annual report of the street cleaning department of the city of Toronto shows that 351,193 loads of garbage were collected last year in that city at a cost of $1.29 per load, compared with $1.23 per load in 1918, and $1.06 per load in 1917.

The newly organized Ontario Cement Co., Ltd., has purchased the plant of the Ontario Portland Cement Co. at Blue Lake, near St. George, Ont., and will remove the plant to Beachville, Ont., where the company has secured 170 acres. The Ontario Portland Cement Co. was organized in 1901 and was operated for 15 years, until its marl beds became exhausted.

INFLUENCE OF FAIR SPECIFICATIONS AND COMPETENT INSPECTION ON BIDDING PRICES*

By H. S. Mattimore
Engineer of Tests, Pennsylvania State Highway Department

THERE are many serious problems confronting highway officials at the present time. One of the main factors on which the accomplishment of this work depends is the securing of large reputable contractors to undertake construction of these highways. It is a pure business proposition with these companies, and there is no reason why they will not seek it, providing the highway officials make it attractive. This does not necessarily mean exorbitant prices. Fair prices with fair treatment, and intelligent, clear specifications with competent enforcement generally prove to be a greater incentive than high prices and extensive delays caused by incompetent inspection, indecision and indefinite specifications.

With very few exceptions, the modern contractor is a big business man, anxious to do good work and maintain friendly relations and thereby establish a good reputation. On the other hand, engineers are fairminded, or at least try to be, and their decisions are influenced only from the standpoint of obtaining what in their judgment is a good quality of work.

Now the causes of conflicts between the engineers and contractors are many and varied, but broadly they can be summed up as a difference in viewpoint. This is bound to exist so long as individuals are of different character and mind, and in fact the stronger the character the more the argument necessary to change the viewpoint. Do not confuse this with ignorant stubbornness. We must be broad enough to realize that there are many problems in highway work that have more than one correct solution.

Specifications Must be Clear

The highway official has full power to specify the character of work that the contractor must perform, and in justice to the state he must see that this work is performed according to these specifications. Now in my mind this is the source of many of the troubles arising during the progress of the work. The contract is taken by the contractor and he agrees to perform the necessary work in accordance with certain specifications. These specifications are written by the engineers and supposedly understood by the contractor. Now, is this latter always the case? Are all specifications clear? As an answer, consult articles in current numbers of engineering and contracting journals, also examine court records of state versus contractor on highway cases. In the latter you will find judge, jury and many legal authorities are trying to interpret various clauses in specifications. This, in itself, should convince us that the specifications must be clear. Make them concise if possible, but do not sacrifice clearness.

There is much to be said regarding specifications. In the first place, they must not be a product of one mind. A really clear and concise specification, if written by an individual, should be done so only after ideas are obtained from men directly connected with the details of construction. Good practice must be adhered to and all methods must be described as definitely as possible.

"Satisfaction of the Engineer"

Do not specify better quality or more detail than you expect to obtain. We have all seen specifications with many paragraphs or phrases which were apparently written to act as a club over the contractor. They were supposedly intended as an insurance against a dishonest contractor. Such an insurance leads to high bids, and large reputable contracting companies will hesitate before bidding under such specifications, and when they do bid it will be high enough to play safe.

Occasionally another type of specification is encountered which is so open and broad that it is dangerous. I refer to

---

*Excerpts from paper presented at a convention of the American Association of State Highway Officials.

specifications, which, instead of definitely specifying qualities and describing methods, will call for work being done satisfactory to the engineers. This type is a survival of the days when the chief engineer or competent assistants could give much time to details. I doubt if such specifications proved satisfactory even then. At any rate, in the present days they would be hazardous for both state and contractor. No man can satisfactorily handle all details in supervising the large amount of work being done at present, and much supervision has to be left to subordinates. It is a careless and unnecessary procedure to place the responsibility of deciding broad questions on men of limited experience. Furthermore, a reader of such specifications is impressed with the idea that the state presenting them was in ignorance of just what they did want.

Factors Affecting Contractor's Relationship

The main factors affecting the relationship between contractor and the state, therefore, might be enumerated as first, the type of specification under which the work is done, next the interpretation of these specifications, and finally their enforcement.

I have briefly discussed two general types of specifications to be avoided, and too much emphasis cannot be placed on these points. In order to play fair, the engineers or other officials responsible, on the part of the state, must see that their specifications are clear in the fact that methods are definitely stated, as far as it is practical to do so. If we expect to avoid friction during the progress of work, we must have a proper understanding of what is expected, and this information should be conveyed in the specification. We cannot expect a better class of materials and workmanship than is available. If we call for this latter, the result will be that if the contract is ever completed we will find that we have not met the specification requirement but will probably be faced with the fact that we paid the price for them. A reputable contractor will take the specifications in good faith and assume they will be enforced. If they are impractical, or not properly enforced, the state is the loser, as a successful contractor prepares for the worst condition and bids accordingly.

Interpretation of Specifications

Now all specifications must be interpreted in many points, and as it is within their authority, this is entirely controlled by the state representatives. The type of a man invested with this authority is a large factor in determining relationship with the contractor, and also has a great influence on future prices. A broad-minded man of experience insists upon an excellent quality of work, but he is reasonable enough not to insist on this being obtained in the most expensive way.

A certain amount of responsibility and some authority has to be given to the inspector on the contract. The experience of this man and his general type has a great influence on the work and the relationship maintained. This is the state employee who is most intimately associated with the contractor, and his decisions, although in many cases of a minor nature, are bound to have their effect on the subject under discussion. It is true, with a good specification, his individual opinions are reduced to the minimum, but we must realize that there are still many points on which he has very little to guide him except past experience and good practice.

Duties of Inspectors

An inspector first is to inspect and insist on quality and compliance with specification. Any failure on his part in this regard is an absolute neglect of duty. It can be said in praise of the engineer or inspector, from a moral standpoint, that a very small proportion deliberately err on the side of neglect of duty, so far as their understanding of the specifications are concerned. In fact, their main faults are improper interpretation of the specifications, insufficient detail knowledge of the different phases of the work, thereby making them uncertain in making decisions. Inexperience, thereby unfitting them to determine between a major or minor cause for complaint, and finally a lack of co-operation with the contractor. This latter, with inexperience, is probably one of the main causes of delays on many contracts. By co-operation, I mean that the inspector should always see that the contract is performed in accordance with specifications, but instead of constantly complaining he should suggest methods for rectifying poor conditions. His aim should be to secure results and co-operate with the contractor in getting them. For example, in working local materials, the inspector is, or should be, informed on what is required, and having facilities for determining this, he can guide the contractor in working deposits so as to insure acceptable material being delivered at the site of the work. Here I wish to emphasize that there is no intention to interfere with the contractor's methods of working. The inspector should co-operate to the extent that no large amount of material will have to be rejected after hauling to the roadside. One can readily see how much co-operation on the part of the inspector, while at the same time maintaining quality, will reduce costs to the contractor, which in the end results in lower bids.

Another factor is, the state also maintains a reputation for fairness, thereby attracting the better and more reputable contractors. An inspector should avoid indecision; a firm, positive attitude on his part will command respect and maintain friendly relations to a greater extent than will the apparent indecision encountered on many contracts. The complaints from contractors on indecision of the engineer or inspector far outnumber those on positive directions, even though the latter are somewhat severe.

Should Furnish Reliable Information

Highway departments should furnish reliable information when calling for bids, as this gives some definite knowledge to the contractor and allows him to bid with intelligence and thereby reduce his so-called contingency or safety item. Under this head might be mentioned sources of approved materials for construction. It is expected that a contractor will inspect the highway before bidding, but having no facilities for determining quality, he must figure on sources of known quality, regardless of economy. All available material sources should be investigated by the state and full information furnished with the proposal or bidding sheet. This investigation of materials should be made as complete as possible. So far as I know, no attempt has ever been made to guarantee these sources in quality and quantity. It is a question for thought whether it may not pay in the end to do so, but regardless of this I know from past experience that the furnishing of full information on material sources without guarantee has proven economical. These sources, although not guaranteed, must be reliable, and great care and pains taken in their investigations or otherwise very little benefit will result.

Highway officials desire to be fair and hope to impress this sense of their fairness on the contractor, not only to attract bidders but from the general idea of fairness itself. In order to do this, we must impress the contractor with the fact that in giving due consideration to the legal side of a contract, we also know and consider the moral side.

The production of building materials in the province of Quebec increased considerably during the year 1919, compared with 1918. Its total value for the year amounted to $7,974,084, compared with $5,340,987 for 1918, an increase of $2,633,097. Practically all the items show higher production, brick having doubled in value, while the quantity produced was 80% greater.

The Standard Tube & Fence Co., Ltd., of Woodstock, Ont., have acquired the Canadian patents of Marshall B. Lloyd, covering acetylene and electric welded tubing, and have formed a close working arrangement with the Standard Parts Co., of Cleveland, O., to manufacture many of the latter's line of welded products. Additions to the plant in Woodstock are contemplated. Meanwhile equipment is being installed in the company's present buildings.

RELATION OF HIGHWAYS TO MOTOR TRUCK OPERATING COST*

By Arthur H. Blanchard
Professor of Highway Engineering and Highway Transport, University of Michigan

HIGHWAYS are merely the means to an end. That end is economic and efficient transportation of passengers and commodities. If this fundamental principle had been the universal basis for the improvement of highways during the past twenty years, the problem of determining the relation of highways to motor truck operating cost would have been materially simplified.

The highway transport engineer or manager cannot assume, for every transportation route, that what has been done is what should have been done. In fact, in the case of any one of thousands of proposed routes, he cannot assume that the highway is 100% improved, even based on the crudest ideas of what constitutes an improved highway. It is well to bear in mind that the construction of highways outside of municipalities is to-day in its infancy. Furthermore, it should be recognized that of the 2,500,000 miles of highways outside of municipalities in the United States, only 12% can be classified as improved, and that not over one-fourth of 1 per cent. are suitable to carry intensive motor truck traffic.

Survey Under Three Classifications

No thorough consideration appears to have been given to the effect of highways on operating cost by many legislators and commissions when establishing schedules of legal rates for transportation of commodities. For example, the Nebraska uniform rate of one and one-half cents per 100 lbs. per mile, recognizes the fact that the roads of Nebraska will not permit a 300-day-a-year business with 5-ton trucks, by entirely failing to recognize the fundamental fact that a 30-mile haul on one route may easily cost twice as much as on another route, particularly as only about 2% of Nebraska's rural routes are classified as improved.

It is evident that a thorough field investigation of every proposed highway transport route should be made, and that the results of this survey should be an improved factor in the final decision pertaining to the establishment of a highway transport business. The result of this survey, from the standpoint of highways, may be roughly classified under the following three heads: First, relation of unimproved highways to operating cost; second, relation of proposed new construction and the reconstruction of improved sections to operating cost; and third, relation of sections of improved highways which will not be reconstructed for a period of less than five years to operating cost.

Unimproved Portions of Highways

The first class of sections of a proposed route—namely, the unimproved portions of highways, may present conditions of narrow widths of roadways, steep grades, sharp turns or rocky, sandy or clayey surfaces, such that a glance will be sufficient to condemn the route for efficient highway transport. Generally speaking, unimproved highways constitute a positive economic barrier to the development of a highway transportation business. Take for example, George H. Pride's 1919 average daily cost of $28.56, covering the operation of a 5-ton truck for an average of 50 miles per day for 300 days per year. These figures are based on New York City conditions, including the average type of improved highways outside of cities over which his trucks operate. Let us diagnose Mr. Pride's cost sheet and determine what would be the effect of substituting a system of poor roads for the system of improved roads in the near vicinity of New York City. It is self-evident that poor roads would materially raise the cost of at least the following items on the cost sheet: Tires; oil, grease, etc.; gasoline; depreciation; maintenance; and lost time. A combination of a rough roadway on steep grades for a mile section of a 25-mile route, might easily double or treble the operating cost, if not actually rendering continuous operation of a truck over such a route impracticable.

The following interesting deduction pertaining to saving in gasoline which will result when the system of 5,000 miles of highways in Illinois are improved has been made by A. N. Johnson. He assumes that these highways will develop a traffic of 500 motor vehicles per day for 300 days in the year. He estimates that the saving of gasoline by the above traffic on improved roads, as compared with earth roads would be 66,000,000 gallons per year, or approximately $15,000,000.

Saving in Gasoline

The results of tests carried out by the White Co., of Cleveland, with a 2-ton motor truck, are of interest as an indication of the saving of gasoline due to operation of motor trucks on some of the types of pavements suitable for trunk highways, as compared with operation over earth roads. The investigations showed that on concrete and brick pavements it was practicable to operate a loaded 2-ton motor truck for an average of 11.5 miles on one gallon of gasoline, whereas on the average earth road only 5.8 miles to the gallon was obtainable. In round figures, the conclusion drawn from the test was that it was possible to operate the 2-ton truck on high-class pavements for twice the distance which was practicable on earth roads.

The second classification of highway sections cover those parts of routes which are liable to be constructed or reconstructed within a comparatively short period after the establishment of a transportation business. This phase of highway improvement demands serious consideration, as construction and reconstruction generally implies that vehicular traffic will be shunted on to detours, most of which are far from satisfactory, considered from the standpoint of economic highway transport. The growth of motor transport will force highway engineers to give serious attention to providing serviceable roadways for traffic during highway improvement. In some cases, roadways are provided alongside the highway under improvement, in others one-half of the highway is improved at a time and in others the traffic uses detours. Highway transportation interests will soon emphatically demand that the same consideration be given to the facilitation of highway transport as is usually provided for railway transport when a railroad line is under reconstruction.

In connection with the third general class of highway sections of a given route—that is, improved sections which will not be reconstructed in the near future—it is necessary to consider the influence of each fundamental element of a highway upon economic highway transport. The elements which will be considered are drainage, foundations, grades, widths of roadway, shoulders, curves, roadway wearing courses and bridges.

Drainage and Foundations

American highway literature contains an enormous amount of advice pertaining to drainage and foundations. Although it is generally conceded that the importance of this subject has not been over emphasized, nevertheless, American practice is far from satisfactory. The writer believes that the increasing use of highways by motor transport will cause so many failures of insufficiently drained highways and others which have weak foundations, that there will be a general improvement in the near future. As loads are transmitted from the wearing course to the foundations and from there distributed to the subgrade, the bearing power of the soil composing the subgrade is an important factor in the design of the highway. It is well known that the bearing power of soils, in many instances, is materially increased by efficient drainage. The roadway, therefore, should be so drained that the maximum bearing power of the subgrade is developed. While a poorly drained

*Presented at the annual convention of the National Highway Traffic Association, January 29th, 1920, in Chicago.

roadway might support a light rural traffic, it will be rapidly destroyed if subjected to commercial motor transport, including, for example, several 5-ton trucks.

The greatest improvement noted in American foundation practice is the use of cement-concrete foundations, or stone foundations of equivalent strength, on state trunk highway systems. The concrete foundation, as a structure, should be analysed from the standpoint of the external forces acting upon it, the stresses resulting from such forces, and the composition and depth of the concrete foundation to provide for the strains within it. Based on statistics furnished by many motor truck companies, the maximum concentrated load under one rear wheel may amount to 11,000 lbs. This load, therefore, distributed over the area of contact of the tire may be considered the force for which the foundation should be designed from the standpoint of direct compression.

The foundation may likewise be considered as a beam or slab, two or four concentrated loads of the above amount being considered as beam reactions, while the upward pressure of the earth against the base of the foundation may be considered as a distributed load. Depending upon the possible position of the loads assumed, the beam or slab may be considered as a continuous structure or one with cantilever projections. Again, assuming that the subsoil under certain sections of the foundation is not in contact with the base of the foundation, a beam or slab action may take place, considering the external force to consist of a single concentrated load of 11,000 lbs. and the beam or slab to have both ends fixed or to have one end fixed and one end free.

It is self-evident that several assumptions may be made relative to pressure on the subsoil, the conditions of the subsoil beneath the concrete foundation, the distribution of the external forces and impact forces.

Regard Foundation as Structure

Although data is meagre upon which to design concrete foundations, nevertheless, it is high time that a concrete foundation should be looked upon as a structure and designed as far as possible according to the methods now used in designing other structures. The design of the foundation is particularly complicated due to lack of knowledge pertaining to the distribution of the load through the concrete, the pressure on the subgrade supporting the foundation, and the manner in which the concrete foundation acts as a structure. It is apparent, however, that a series of assumptions may be made upon which the design of the concrete foundation may be used, and that the results may be used as a guide to determine the composition and depth of the foundation.

The highway transport engineer or manager can neither assume that drainage systems and foundations have been scientifically designed, nor that these important elements of a highway have been constructed in accordance with practice based on service tests. Highway transport literature contains many references to cases where motor trucks have become mired in poorly drained roadways or have broken through wearing courses supported by weak foundations.

When the transport survey is made, care should be taken to determine, by inquiries along the route, the ability of the roadway to carry heavy loads, during the spring especially. It is well to keep constantly in mind that an ideal roadway surface is not necessarily an indication that the drainage system and foundations are suitable for motor truck traffic.

From the foregoing discussion it will be seen that poor drainage and weak foundation on a section of a transportation route may readily wreck a highway transport business, or at least require the charging of higher rates to cover increased cost of operation.

Grades

Only general deductions may be made pertaining to requirements relative to grades for motor transport. Unfortunately, little data is at hand covering the relative efficiency of truck transportation over various grades on different types of roadway surfaces. Of course, the general deduction may be made that the cost of haulage varies directly with an increase in grade and that the tonnage which can be economically hauled varies inversely with an increase in grade. In all probability, the present fundamentals of grade design will not be modified until sufficient data has been accumulated to demonstrate that present practices are uneconomical either from the standpoint of motor transport or the maintenance of the roadway.

The cost items relative to tires, grease, oil, gasoline and lost time, and probable depreciation and maintenance, will be increased by material grades on transport routes. General allowance can be made, but close estimates are impracticable unless the transport engineer has had experience with exactly the same conditions which he encounters on a new route.

Widths of Roadway and Shoulders

Roadways economically designed must provide for carrying the traffic on the paved roadway surface and not rely upon earth shoulders to carry a part of the traffic or serve as turnouts. It has been demonstrated that the latter practice is not economical from the standpoint of the maintenance of the pavement or shoulders, nor is it efficient or safe from the standpoint of traffic using the highway.

In order that a two-traffic line highway should be satisfactory for all classes of vehicular traffic, it will be necessary to follow English inter-urban traffic practice, which requires that slow-moving—or, in this case, commercial—traffic, shall keep to the side of the roadway. It is, however, obvious that a heavy motor truck operator will insist upon allowing a certain amount of leeway between the outside wheels of the truck and the edge of the roadway, as many operators have had unfortunate experiences with motor trucks being stalled in soft shoulders or ditched.

From observations of commercial traffic made on many highways outside of municipalities, it is the writer's conclusion that it will be necessary to allow at least a foot clearance between the body of the truck and the edge of the paved roadway. Furthermore, these observations indicate that motor truck drivers travelling at speeds from 10 to 15 miles an hour will endeavor to maintain a clearance of 2 ft. between passing vehicles. A compilation of the maximum width of 8 ft. for each of two trucks and the clearances suggested, indicates that a minimum of 20 ft. for two lines of traffic is a conservative recommendation. It should be observed that the county highways of England and the national routes of France have been constructed with roadways having widths of not less than 20 ft. for many years.

If the transportation survey indicates that the amount of traffic will require provision for more than two lines of vehicles, a greater width than 20 ft. should be adopted, the additional width depending upon the character of the traffic. It does not require much imagination to reach the conclusion that many inter-urban highways will be subjected, during the next decade, to traffic which will necessitate roadways sufficiently wide to accommodate at least two lines of motor trucks and two lines of passenger cars.

The above discussion indicates that highway transport investigators will do well to give careful thought to widths of roadways on a proposed route. On a narrow roadway, say from 9 to 14 ft., there will be, in many cases, continual danger of running onto earth shoulders, with resultant serious loss of time if the truck should become stuck in soft material. Furthermore, a given width of roadway is able to carry a certain maximum traffic. As this limiting amount of traffic is approached or exceeded, there will be serious loss of time due to congestion of vehicles. The cost item of lost time, therefore, may be materially increased due to narrow and inadequate roadways existing on a given transport route.

Curves

Motor vehicle traffic has effected a decided improvement in the design of highway curves, especially in the direction of the easing of sharp curves, provisions for clear sight around curves, and the banking of roadways. The importance of these details will be accentuated by the development of motor truck traffic. Many routes have so many sharp curves that this element of highways may effect economic transport through lost time in negotiating such turns, in-

creased wear of tires and possible depreciation and maintenance due to collisions or other accidents.

Roadway Wearing Courses

The forces due to motor truck traffic which should be given consideration in the selection of a roadway wearing course are the direct load-causing compression in the wearing surface, impact forces and sheering forces of the driving wheels (the amount of which will be a function of the weight of the vehicle and the speed at which it travels). If all of these forces have not been given proper consideration, the wearing course will wear rapidly or will disintegrate. The wearing course is of particular interest to motor truck users, because of the variations in resistance to traction on different types of roadway surfaces.

Statistics are meagre relative to traction, especially as concerns motor trucks. Investigations made to date are merely a drop in the bucket as compared with the amount of research which should be undertaken in order to have available reliable data. At the present time, only the most general conclusions can be drawn, as was the case with the tests carried on by the White Co., cited above.

Highway transport interests should give careful consideration to the effect on motor trucks due to travel on different types of roadway wearing courses. The mistake is too often made of considering wearing courses in their ideal state or during the first six months after completion. All types wear under traffic, and hence the character of the surface of a roadway after two to five years' life is generally more important than its condition upon completion of an improvement. Not only is resistance to traffic increased as the surface becomes worn, but furthermore, the effect on the motor truck through impact forces caused by travel on rigid monolithic pavements will result in a material advance in depreciation and maintenance charges.

Bridges

A bridge is an integral part of a highway. It is to be regretted that this fact usually has not been recognized by law-makers. Many highways are built of sufficient strength to carry the motor traffic to which they are subjected, while the bridges are so weak that their condition prevents the use of the highway by a part of the motor truck traffic. Many citations may be given of highways which have had to be abandoned as commercial transportation routes due solely to the weak conditions of the bridges. One reason for this condition is that many state laws provide for the construction and maintenance of roadways by the state, while the bridges are under the jurisdiction of counties or towns.

It is self-evident that bridges of trunk highways connecting municipalities should be designed for loads of not less than 30,000 lbs., and it would appear advisable, considering the character of the structure, to follow the practice of the Pennsylvania State Highway Department and design highway bridges for loads of 40,000 lbs.

The clear width of the roadway of a bridge should comply with the requirements pertaining to roadway width cited above. In addition, the vertical clearance should be given consideration, and in this connection the overall height of 12 ft. 2 ins. for motor trucks should receive attention. This is an important factor, not only in the design of through truss bridges but likewise in providing for clearances underneath railway bridges.

Highway transport companies should thoroughly investigate permissible loads, clearances and roadway widths of highway bridges on transportation routes. Many instances have come to the attention of the writer where bridge load limits of two or three tons occur on highways whose surfaces are capable of carrying 5-ton motor truck traffic.

English Practice

A discussion of the relation of highways to operating cost would be incomplete without reference to the large fund of general information which may be found in the motor truck literature of England, where highway transport outside of municipalities has been under development for several decades.

The status of motor transport in England in 1909 is aptly described in the following statement by Col. R. E. Crompton:—

"Although our roads come first, and their development occupied the best thoughts of our leading engineers at the time of Telford, when railways were introduced, road development took a second place until quite recently, when it was seen that the general introduction of motor vehicles was rapidly bringing back the roads into favor, not only for carrying passengers and distributing materials for short runs, but to act as feeders to the railways, and in many cases to become rivals to the railways themselves for short hauls, or, in fact, in all cases where economies in the terminal charges and in the packing of goods, especially those of a perishable character, can be effected by these goods being loaded at the starting point into a vehicle which carries direct to the consumer without transhipment or intermediate handling.

"The economical advantages of this last consideration are so great that many business firms have now found that they prefer to deliver direct in their own vehicles goods which they had hitherto to send by their horse-drawn vehicles to the railway stations and which had to be twice transferred, first from their vehicles on to those of the railway, and again from the railway vehicles to the railway vans.

"A study of the statistics of increase of traffic on roads radiating distances of at least 30 miles from our large business centres, has shown us that, as the vehicles and as the roads themselves are improved, this radius of direct haulage is likely to increase, and will probably have a very important effect on the distribution of the population, and must with absolute certainty be reckoned with in considering all questions of construction and upkeep of the roads themselves."

Conclusion

The foregoing discussion indicates that the probable cost of transport over highways outside of municipalities is not susceptible of an exact mathematical analysis. Although this situation is far from satisfactory, it does not mean that highway transport should not be based on as definite analysis as our present fund of information and experience warrants.

The inter-relationship between highways and the cost of highway transport is so interwoven and complex that many highway transport managers have literally thrown up their hands and simply taken a chance upon the results to be secured from organizing transportation companies.

Based on the meagre investigations made to date, taken in combination with the combined experience of English and American highway transport authorities and highway engineers, it is evident that certain general conclusions may be drawn as a result of a careful highway transport survey for any proposed transportation business. A consideration of these deductions will usually warrant the installation of a highway transport business or the positive rejection of the proposition. This is particularly true when it is considered that the installation of highway transport in a given community should not be based on a narrow margin of profit. There are too many uncertain factors, such as competition with other transport companies and common carriers by rail and water, state regulations pertaining to weights, dimensions and speeds of motor trucks, legislation pertaining to licenses, franchises and rates, snow removal practice, and variations in the volume of business, to justify a highway transport engineer or manager figuring profits and losses from a business standpoint in thousands of dollars and the variations in operating cost due to the several highway factors in thousandths of a cent.

Next winter the Toronto-Hamilton highway will be kept clear by means of snow plows operated from Toronto, Oakville and Hamilton.

The architects of British Columbia have introduced a bill in the Legislature of that province incorporating the Architectural Institute of British Columbia.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

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

Published every Thursday by

The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND

Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.

Telephone, Main 7404. Cable Address, "Engineer, Toronto."

Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

REMUNERATION OF SURVEYORS

REPRESENTATIONS are being made by the Association of Dominion Land Surveyors to the Civil Service Commission in regard to the classification and remuneration of surveyors in the employ of the Dominion government. At the present time comparatively few surveyors employed in Ottawa on office and routine work are being paid more than $7 a day. The salary of the surveyor-general is only $4,000 a year. The highest salary paid last year to any man in the field was $9 a day, with the exception of chiefs of parties who were working on international boundary surveys—obviously important work calling for the greatest accuracy—who were paid $12.50 a day. The chief of a field party of 24 men, working on base-line surveys, controls the expenditure of between $25,000 and $30,000 a year. The chief of a party of 20 men, working on sub-divisions, land settlement and clearing, controls an annual expenditure of over $15,000 and is paid $9 a day.

To junior engineers these salaries may seem fairly liberal compared with those that have been offered in the past to some men engaged in purely engineering activities, but it must be remembered that many surveyors who are doing field work for the Dominion government cannot depend upon more than five or six months' employment each year at those rates, and for the remainder of the year they must find other means of livelihood unless they can secure office positions. It is the uncertain term of employment that inflicts the hardship upon the surveyor, rather than the actual daily rate of remuneration. If steady employment cannot be guaranteed, naturally the remuneration must be increased as a compensating measure.

As C. A. McGrath pointed out last month at the annual luncheon of the Dominion land surveyors, there has probably been no branch of technical service from which the government has received better value per dollar spent than from the various branches engaged in surveying. There is no 6-hour day nor 8-hour day for parties in the field. They work hard from sunrise to sunset, regardless of the fact that there is no supervision and no direct check on their conduct. The zealous interest and professional pride in their work that has been shown by nearly all surveyors, could well be taken as an example by all other bodies of government employes. Any increase that the Civil Service Commission may see fit to grant to the surveyors will receive the hearty endorsation of all other technical employes of the government who are familiar with the arduous work performed by the field parties and the hardships that they must often endure.

Letter to the Editor

DEVELOPMENT OF SEWAGE PURIFICATION

Sir,—Certain of the technical journals are raising the question as to who is or is not the inventor of the so-called "activated sludge" process. I cannot help thinking that this is hardly a question of invention but rather one of evolution, and that anyone working along a set course with the same object must of necessity have arrived at a like result,—in this case at "activated sludge."

Looking back over the past 30 or 40 years of my life and its association with sewage purification works and the engineers who were responsible for them, I cannot help knowing that this is a simple fact as far as sewage at least is concerned. In the old days of, say, Sir Robert Rawlinson, Mr. Eassie, Bailey Denton, Rogers Field, Dr. Bruce Lowe, Prof. Douglas Galton and others,—that coterie of early sanatarians,—we had the first process, simple land irrigation after tankage, then chemical precipitation with its troublesome secondary decomposition and sewage-sick land, then the intermittent discharge of tank effluent onto the land by means of Field's syphon, and always the creation of sludge to be pressed into cake, or to foul the land it was stored on, or to be barged out to sea as at Barking and Salford.

Chemical treatment and land filtration had their long life until Mr. Dibden, who was at that time chief chemist to the London county council, found that at Barking a half-acre rough filter absorbed and was able to digest the increasing volumes of sewage which he put upon it; this was the origin of the bacterial contact bed.

The Sutton beds followed, replacing the chemical precipitation tanks, and Sutton became the "Mecca" of men seeking light on matters sanitary, at least as far as sewage purification was concerned. The filtrant here was simply burnt clay, but this artificial filter served its purpose better than the natural land, and was able to deal with three fillings per day. The liquid content of the bed was one-third its cubic capacity, the filtrant occupying the remaining two-thirds.

In the meantime Mr. Cameron, the then city engineer of Exeter, introduced his septic tank. He trapped the inlet pipe to and the outlet pipe from his sewage tank with a view to preserving the top scum and preventing the active life which developed within being drawn off, and he covered over the tank, believing that the anaerobic bacterial action which was necessary for the dissolution or breaking up of the organic matter was aided thereby. (These covered tanks were dangerous. Serious explosions have resulted from their use, one particularly at Sheringham, where part of the esplanade beneath which the tank was built—with masses of concrete and tons of sand—was blown into the air. In this explosion two men lost their lives.)

It was suggested that the gas (a marsh gas which burns well through a mantle) might be used for lighting purposes, but the amount obtained,—I believe about one cubic foot per person,—was insufficient for any practical purpose. The Swiss tank, commonly known as the "Fosse Mouras," was

constructed on similar lines. Having provided for the dissolution of the organic matter by the anaerobic process, it was necessary to oxidise the resulting tank effluent, and this was done in the contact bed by means of anaerobic bacteria which were cultivated within it. These contact beds, whilst they produced a satisfactory effluent, had their limitations. It was essential that the sewage should remain in contact with the filtrant for two hours and then, after emptying, that the bed should rest empty for aeration. It was natural, therefore, that a continuous process should be sought for; the first of this class was the late Major Tullock's percolating filter built at Sutton adjoining the Dibden contact beds. This was a rectangular filter. The filtrant was enclosed between pigeon-holed walls and the tank effluent was distributed over the surface through shallow troughs.

Next came Mr. Caink's application of the revolving sprinkler as a means for spraying a sewage filter. Such circular filters with the various types of revolving sprinklers are too well known to need description. By their means a perfect effluent is assured with the simplest mechanism.

In the United States, the late Col. Waring (who was the pioneer sanitarian in the States) blew air into the hollow floor of his contact beds so long ago (more than 20 years) that photographs I took then are fading fast away,—with more of other methods for treatment by aeration. These, with Mr. Lowcock's (Birmingham) experiments with air, led gradually on, stage by stage, to what we now know as the activated sludge treatment. The late Mr. Corbett of Salford (to whose courage in the face of much criticism the spray filters of Salford are due) laid air pipes on the floor of his roughing filters. His idea was to aerate his filtrant; it was not a great step to remove the filtrant and agitate the sewage in that tank by air.

Following close upon the air-activated sludge, we have the mechanically-activated sludge tanks by means of movement pure and simple. This work of Mr. Howarth's at Sheffield will surely be the precursor of great changes in methods of sewage purification. We shall look for the intensive treatment of sewage wherein machinery will take the place of filters. The sludge problem still remains as the "Old Man of the Sea."

It may be our ill fortune, that in this country we have to rely upon individual effort rather than upon State guidance. On the other hand, the outcome of individual thought, given the right environment, as at Manchester, for example, where Dr. Fowler and others concentrated on this subject, has been more than sufficient to keep pace with the State-aided work of the Lawrence, Mass., experimental station. Under the supervision of Dr. Clarke, an immense number of experiments have been made, and their records most carefully tabulated. The continuous and painstaking work carried on at this station must of necessity have far-reaching results.

The length of this letter has outstripped my intentions, which were to state very briefly—for the benefit of others who may not know the facts—how to me these changes from land irrigation, chemical precipitation, contact beds and percolating filters to activated and mechanically agitated sludge, are but simple evolutionary stages in the solution of a difficult problem; and I venture to think that those earnest workers to whom we owe so much are not concerned as to their priority as users of any one process, so long as their joint efforts produce the result they seek.

S. H. ADAMS,
Managing-Director,
Adams-Hydraulics, Ltd.

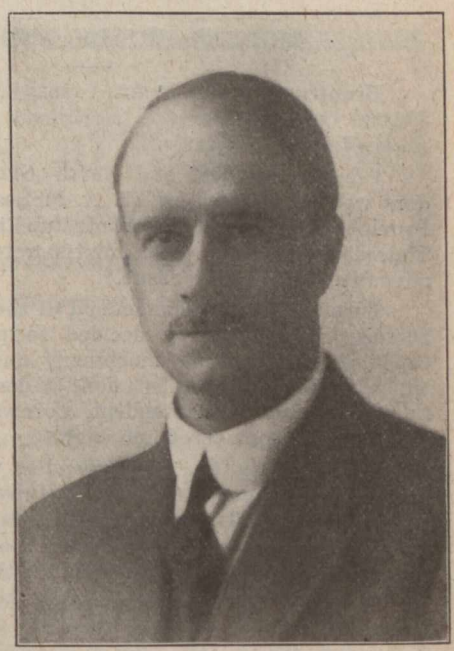
York, Eng., March 4th, 1920.

OBITUARY

ARTHUR DINNIS, president of Richard Dinnis & Son, general contractors, died last Thursday at his residence in Toronto, following an attack of heart disease. Mr. Dinnis was born 55 years ago in Toronto. He was connected with the construction of many prominent buildings in that city.

PERSONALS

HERBERT P. HEYWOOD, who was recently appointed engineer of sewers and drainage for the Toronto Harbor Commission, was born in 1889 in Lincoln, Eng., and was educated at the Lincoln Municipal Technical College. From 1906-9 Mr. Heywood was an articled pupil to the Lincoln water works engineer, and for the following year he was assistant engineer on the design and construction of a new water supply for Lincoln. In 1910 he was promoted to the position of assistant division engineer on the above-mentioned construction, but resigned in May, 1911, and came to Canada. He secured a position with the C.N.R. as engineer in charge of construction of divisional buildings at Regina, Sask. Upon the completion of that work he was assistant engineer on maintenance-of-way for three months, and was then employed as a draftsman on masonry substructures in the office of the C.N.R. bridge engineer. From 1913-4 Mr. Heywood was assistant division engineer for the Manitoba Government on road and bridge construction, and for the following two years he was bridge and senior concrete inspector for the Greater Winnipeg Water Board during the construction of the Shoal lake aqueduct. He enlisted in 1916 and went overseas July 4th as a sergeant with the 3rd Canadian Railway Troops, and was in France until March 28th, 1919, engaged in the construction of light and standard gauge railways. After his release from military duties, Mr. Heywood was engaged as the English representative of the Lock Joint Pipe Co., of New York, and a few months later he was transferred to Canada and became that company's representative in Ontario, which position he resigned last December.



J. CLARK KEITH, assistant city engineer of Moose Jaw, Sask., has resigned to join the staff of Morris Knowles, Ltd. Mr. Keith will be manager of the company's office in Windsor, Ont. He has been on the engineering staff of Moose Jaw for the past eight years, and was previously connected with the Irrigation Branch, Department of Interior, at Calgary. Mr. Keith was an honor graduate at the University of Toronto, class of 1910.

HAROLD STANLEY JOHNSTON, of Calgary, Alta., has accepted an appointment as hydraulic engineer on the staff of the Nova Scotia Power Commission. Mr. Johnston is an engineering graduate of McGill University, class of 1909, has had experience in hydro-electric work in Ontario and Alberta. He was engineer of the Calgary Power Co. for four years, supervising the construction of storage dams and two plants of 30,000 h.p. capacity. He was also engineer for the Dominion Parks Branch in connection with water supply for Banff and the Rocky Mountain International Park. For the past 18 months he has been assistant western district superintendent of the engineering branch of the Department of Soldiers' Civil Re-establishment, with jurisdiction from Winnipeg to Victoria, including the construction and maintenance of hospitals, vocational schools and a $500,000 sanatorium. Mr. Johnston's immediate duties will be the preparation of designs and estimates for the Sheet Harbor project to supply the Pictou county industrial district.

CONSTRUCTION NEWS SECTION

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

BRIDGES, ROADS AND STREETS

Brantford, Ont.—Brant county council plans to spend $26,000 this year on road machinery. Road superintendent, A. M. Jackson, Brantford.

Clinton, Saltfleet and North Grimsby Tps., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, up to 12 o'clock noon on Thursday, April 8th, 1920, for concrete culverts. (See official advertisement in this issue.)

Cornwall, Ont.—The council of the counties of Stormont, Dundas and Glengarry decided to purchase one complete outfit of road-making machinery and have the work, for which tenders were called, done under the direction of J. G. Cameron, road superintendent, Cornwall, all the tenders received being considered too high.

Edwardsburg Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until 12 o'clock noon on Tuesday, April 6th, 1920, for work on the provincial highway in the township of Edwardsburg. (See official advertisement in this issue.)

Etobicoke Tp., Ont.—Township council decided to widen Queen St. Clerk, Stephen Barratt, Islington, Ont.

Grand 'Mere, Que.—Grand 'Mere and the county of Champlain at large contemplate the creation of a board of trade, the main and initial task of the board to be the promotion of the idea of a national highway that would lead from Montreal to Quebec by way of the northernmost centres of upper Quebec.

Haldimand County, Ont.—MacConnell and Hicklin, contractors, of Toronto and Ottawa, have received a quarter million dollar contract for water-bound macadam roads in Haldimand county, Ont. The contract includes 15 miles of 16-ft. road at $15,000 a mile; 4 miles at $6,500 a mile; and 3½ miles at $8,500 a mile. The first road runs from Cayuga to Dunnville, and the others are in the vicinity of Hagersville and Jarvis.

Hamilton, Ont.—City council let contract to the Western Oil Co. for road oil for 1920 at 13.4 cents per Imperial gallon.

Kingston, Ont.—The board of works has recommended acceptance of the tender of Imperial Oil, Ltd., for supply of paving asphalt.

London, Ont.—City council decided to purchase one 10 h.p. motor to replace a steam engine on the concrete mixer at the paving plant. City engineer, H. A. Brazier.

London, Ont.—Works committee agreed to place Briscoe St., between Ridout St. and Wortley Rd., on the paving program for this year.

London, Ont.—City council may rebuild Dundas St. bridge. Concrete construction. City engineer, H. A. Brazier.

Montreal, Que.—Tenders, addressed to the Administrative Commission, will be received up to Monday, March 29th, 1920, for alterations to St. Dennis St. tunnel. (See official advertisement in this issue.)

Nepean and Edwardsburg Tps., Ont.—Tenders for concrete culverts will be received by W. A. McLean, Deputy Mininster of Provincial Highways, Toronto, until 12 o'clock noon on Tuesday, April 6th, 1920. (See official advertisement in this issue.)

Niagara Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, up to 12 o'clock noon on Wednesday, April 7th, 1920, for earthwork and other necessary work on the Provincial Highway in Niagara township. (See official advertisement in this issue.)

Quebec, Que.—Residents of Northfield and Gracefield have addressed a petition to Hon. T. E. Perrault, Provincial Minister of Colonization, asking for the construction of a bridge over the Gatineau River, between these two municipalities.

Rockwood, Man.—Tenders will be received by V. W. McFarlane, secretary-treasurer, Stonewall, Man., up till noon on Wednesday, April 21st, for grading of roads. Plans and specifications may be seen at offices of A. McGillivray, highway commissioner, Winnipeg, or D. M. Mawhinney, municipal engineer, Stonewall, Man.

Sandwich, Ont.—Essex county council considering a good roads' system to act as feeders to provincial highways planned by the Ontario Government. Road superintendent, W. H. Knister, Sandwich.

Simcoe, Ont.—Ratepayers passed by-law, authorizing the issuance of debentures for the construction of four bridges to the amount of $58,000. Town engineer, G. R. Marston,

Streetsville, Ont.—Ratepayers passed a by-law to build a $25,000 Tarvia-bound macadam road on the main street. Clerk, S. H. Smith, M.D.

St. Thomas, Ont.—Board of Works let contract for the paving of the remainder of Talbot St. to the Standard Paving Co., Toronto. This was the only tender received. It involves an expenditure of $60.580.

Toronto, Ont.—Works Commissioner Harris has recommended the widening of the pavement on both sides of the track allowance on the north side of King St., between Dufferin St. and Wilson Ave., and on the south side, between Wilson Ave. and Sunnyside.

Toronto, Ont.—Board of Control passed the recommendation of Works Commissioner Harris to rebuild north Glen Rd. bridge at cost of $635,685.

Toronto, Ont.—City council gave the third reading to the bill to authorize the construction of an asphalt pavement on Teraulay St., from Dundas St. to College St.

Toronto, Ont.—R. C. Harris, Commissioner of Works, will report to Board of Control on the cost of reconstructing St. Clair Ave., from Yonge St. to Caledonia Rd to one level, so as to enable the whole of the street to be used for vehicular traffic.

Toronto, Ont.—Works committee approved Works Commissioner Harris' recommendation regarding the widening and grading of Bloor St., from High Park Ave. to Jane St. Estimated cost, $185,000.

Toronto, Ont.—Works Commissioner R. C. Harris recommended the construction of a 28-ft. asphalt pavement on Avenue Rd., from Bloor St. to Dupont St. Estimated cost, $91,436.

Toronto, Ont.—Works committee decided to call for a report on the cost of cutting off six inches of the sidewalk on the north side of Albert St., between Yonge and James Streets.

Toronto, Ont.—City council intends to construct an asphalt pavement and concrete curbing on part of Wellesley St., at a cost of $28,582, and a bitulithic surface on part of Prince Arthur Ave. at a cost of $7,317.

Toronto, Ont.—Works committee approved recommendation to reconstruct and widen Howard St. asphalt pavement, at a cost of $41,438; also construction of asphalt pavements on Glenrose Ave., $30,876, and Harvie Ave., $13,553.

Vancouver, B.C.—City Engineer F. L. Fellowes submitted to the civic board of works a list of streets and lanes which need improvement, the estimated cost of which is $34,760.