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SOME PROBLEMS OF THE WATERWORKS EXECUTIVE*

ADMINISTRATIVE SYSTEM APPLIED TO DISTRIBUTION, SERVICE CONNECTIONS, FIRE SUPPLIES, METERS AND ACCOUNTS

By **GARRETT O. HOUSE**
General Superintendent, Bureau of Water, St. Paul, Minn.

THE waterworks executive is expected to administer the affairs of his office efficiently, and, inasmuch as the efficiency equation involves the proper way to do work, and also the way work is performed, he must be qualified to know how the different divisions of his department should be conducted, how individual work should be performed, and he must also know how the actual work is conducted and how much is accomplished. The ideal of the waterworks executive is furnishing an adequate amount of pure and wholesome water for all purposes to all citizens indiscriminately, under reasonable conditions and at reasonable rates. This is the main problem, and its fulfilment involves many lesser problems.

In order to bring out the problems of the waterworks executive, I will, because of my intimate knowledge and connection with the bureau of water in St. Paul, analyze the organization chart of the water department of the city of St. Paul. As will be noted on the accompanying graphic representation of our organization, the commission form of charter under which the municipality of St. Paul is governed provides that the affairs of the water department shall be administered through an elective board of water commissioners, of whom the commissioner of public utilities is president, and the commissioners of public works and of finance are members. The charter provides that the commissioner of public utilities shall administer, as president of the board of water commissioners, all of the general business of the water department; that the commissioner of public works shall have charge of all engineering and construction; and the commissioner of finance shall collect all revenues. The charter also provides for a central purchasing agent, who purchases all supplies and material used by the water department; also that the comptroller shall prescribe the method of accounting and audit all accounts of the water department. He also, as civil service commissioner, certifies to the eligibility of all employees, and also audits all payrolls. From this it is evident that the activities of the water department are, by charter provision, placed in the hands of many individuals. Since all of these activities are dependent and interlock one with the other, it was deemed necessary and advisable for each of the elective officials to deputize one person to administer, under their direction, the authority which the charter has vested in them. To this person has been given the title of general superintendent and he becomes the executive of the water department.

A waterworks, as a rule, is a monopoly, and the opportunity is given to make unreasonable rules, decidedly in favor of the company or department. Water is a necessity, and no commodity contributes so much to the health and prosperity of a community as water, therefore the service should be within the reach of all.

Under this same general heading may be considered rates, which, however, are determined not upon theory but from actual facts. The waterworks executive, having made the rules and regulations and rates under which the department is to be operated, now turns his attention to perfecting an organization through which all the various activities of the department may be carried on, and the rules and regulations laid down may be carried out.

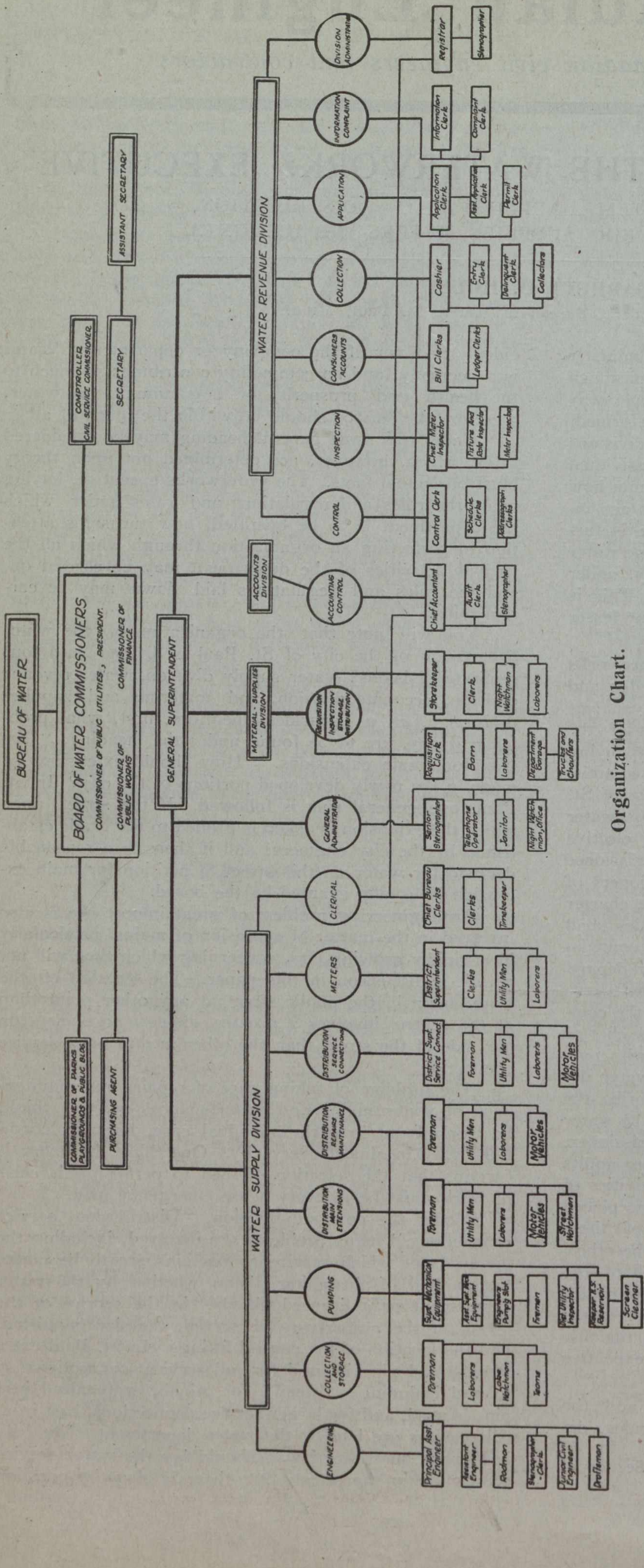
You will note that the organization of the water department of the city of St. Paul is divided into four separate divisions: water supply division, water revenue division, accounts division, and materials and supplies division. Let us consider, therefore, first, what problems, if any, are to be found under the heading, "Distribution, main extensions." How should extensions be made in the newly developed portions of the city? In St. Paul, one general rule is followed. If the street upon which the extension is asked is graded to the grade established by the city engineer, and if there is a reasonable demand for water on this street, a petition for main extension is usually granted by the board.

An engineering problem of great importance is also involved in the matter of extension of mains, particularly in a rapidly growing city, concerning which time will not permit a discussion in this paper. The location of the water main in the public street at any other point than at the centre involves a greater expense to owners on one side of the street than the other in making a service connection.

The problem of taking care of repairs and maintenance of water mains and appurtenances must, I think, be worked out in each individual case, because conditions vary in almost every city. One thing, however, is certain, that the selection of men to perform this class of work must be in every sense emergency men.

Under the next sub-division, "Distribution, service connections," many problems are involved, including the materials of which service connections are to be made, the method of installing them, whether by the water department or a licensed plumber in the service of the owner of the property to be served, the size permitted, and the location of the control fittings. In St. Paul extra strong lead pipe is used for all service connections up to and including 1½-inch; for 2-inch, galvanized iron pipe is used, and for larger service connections, cast iron. All services are laid by the water department. Not only is there a question of who should lay the water service connection in the street, but there is also the question

*Abstract of paper read before the Minnesota Section of the American Water Works Association.



Organization Chart.

of who should maintain it. In St. Paul, at present, it is laid by the water department at the expense of the owner of the property and thereafter maintained by the water department, also at the expense of the owner of the property.

In this division we also have the problem which, as yet, remains unsolved, service connections to private fire supplies. This has been a subject of much discussion in engineering and waterworks societies, and there is a decided difference of opinion. It is a most important problem, and I believe should be solved by accepting a procedure midway between the theory of the National Board of Fire Underwirters and the practice of some waterworks engineers and executives.

It seems to me that the provisions of the National Board of Fire Underwriters with respect to the size of service connection necessary for supplying automatic sprinkler equipment is in many cases entirely too liberal and does not take into consideration the elements which must enter into a determination of water supply. The board of fire underwriters requires, for instance, that a 6 inch service connection must be supplied for sprinkler equipment located in one fire area in excess of 85 sprinkler heads. No consideration is given the matter of pressure, and notwithstanding the fact the National Board indicates that one sprinkler head will reasonably protect 10 square feet of area, the manufacturers of automatic sprinkler equipment very often plan and install sprinkler equipment so that one head is placed to considerably less than 10 square feet of area, which makes, under the rules of the National Board of Fire Underwriters, the larger size service connection necessary.

The use of water from the fire service for other purposes than extinguishing fire is a problem which confronts the waterworks executive, and is generally dealt with either by sealing and inspecting all drip valves on the system, or by placing some form of meter or detector in the service line. In my judgment, a clear distinction should be made between supplies to be used for extinguishing fires and those to be used for domestic purposes, and under no consideration should domestic service be taken from a fire supply line. The charge made for private fire service should include water consumed for periodical testing of the system, losses from evaporation and water used for extinguishing fires. This being the case, it is only necessary to introduce in the service connection a device which will indicate that water has been used. The question of how much is not important. This will effectually prevent continuous use of water for any purpose other than that for which the service is installed. If it is found, for instance, that the service is used more frequently than would be necessary for inspection or make-up water, inquiry can be promptly made and the proper remedy applied. It is, I think, important that the consumer to whom private fire service is supplied should be required to give a bond of sufficient size to guarantee fulfilment of contract provisions. There is also the necessity for the adoption of uniform practice in this respect by all waterworks operated under the same general conditions.

The next problem which confronts the waterworks executive is that of meters, and there is little question but the selection of water meters is a problem to every waterworks executive. This problem is more complicated in a municipality where the charter and ordinance provisions are in force similar to those in St. Paul, where the central purchasing agent is required to award a contract for purchases exceeding in amount $500, upon formal bids, to the lowest responsible bidder. This makes it necessary for the executive to prepare specifications which will either represent the water meter his judgment considers the best, which would be considered discriminatory, or else prepare an open specification which shall permit the manufacturers of all water meters to bid and be satisfied to accept that meter which will be furnished for the lowest price. Two years ago, when this provision was first in effect in St. Paul, bids were received for water meters upon a general specification, and after tabulation, the contract committee asked the writer to make a recommendation. Knowing full well the provisions of the charter with respect to purchases of all supplies, the following recommendation was made:—

"It is my judgment that the city should buy that meter which, in addition to complying in all respects with the specifications, represents the lowest unit cost during its life, the determination of which involves an equation having only one known quantity (first cost) and several unknown quantities."

For both service connections and meters, history cards are started when the service connection is installed or the meter is purchased. Upon these cards are recorded all that happens to the service connection or the meter, including all elements of expense. These cards are found of great value because they represent the life history of either the service connection or the meter.

The problems involved in the material and supplies division are very interesting. Time will not permit their analysis in this paper.

The accounts division is of great importance, but is not always given the attention it should have.

The water revenue division, as you well know, represents the activities of the department of the waterworks which come in direct contact with the public. On this account many problems are involved, particularly in its organization and administration. You will note that the organization of the St. Paul waterworks is administered by a registrar who directs all of the subdivisions. These sub-divisions are made so that each man has a separate and distinct branch of business to transact, affording the person who has business with the department the facility of transacting it rapidly and avoiding what is so common, being referred from one division to another. Information and complaints are given very careful consideration in our organization, and the heads of these sub-divisions are trained and cautioned to always assume that every complaint is real to the complainant and not to take uncomplimentary remarks about the department as personal. It is here that calmness and courtesy count; our slogan is "Service."

In making up the organization chart to which reference has been made, it is intended to classify and group the different functions logically, making a single officer responsible to the general superintendent for the direction of each function. The functions of each sub-division have been clearly defined by bulletin and the duties and lines of authority of each position have been standardized and defined. While experience has shown that this organization has operated smoothly and accomplished very definite and satisfactory results, it is also shown that slight readjustment in some of the divisions will give better results and these changes will be made at an early date. An executive must train himself to be awake, to make changes in his organization when experience shows that the change is necessary and will effect an improvement in administration.

OTTAWA AND ST. LAWRENCE RIVER REGULATIONS.*

By C. R. Coutlee, M.Can.Soc.C.E.,
Engineer in Charge, Ottawa River Storage.

THE St. Lawrence valley extends as far into America as the Mediterranean extends into Europe—two thousand miles. The St. Lawrence River, of which the Ottawa is a tributary, has a basin of about half a million miles. Montreal is about half-way of the river's length, and also marks about half the basin area.

The basin produces trees, grain, grasses, iron, minerals and water power. It is probably the best home in the world for whites, but owing to the severe winter practically half the year is lost in the Canadian part of the basin.

Excepting the Ottawa, none of its tributaries are very large. The Great Lakes form natural storage, amounting to one hundred thousand square miles, but the connecting channels require to be dammed and throttled in order that the storage may be used to full advantage.

The river is an international stream, and consequently suffers from divided ownership. Again, it is bordered by provinces, states and powerful municipalities, so that harmonious work towards betterment is impracticable.

Besides its natural use for water supply and recreation it is artificially used for navigation and water power and is misused as a cesspool.

Power bids fair to become the most important use of the river, because the navigation from Niagara to Montreal is a comparatively small tonnage of one or two million tons against sixty million tons between Lake Superior and Lake Erie.

The river now produces about half a million horsepower, but at the end of this century it should produce six or seven million horse-power. This could be brought about by co-operation between the United States Federal Government and the Canadian Federal Government.

(1) By buying out all the powers along the main river at present situated at the Sault, Niagara Falls and Massena.

(2) By constructing regulating dams at each change of level from Lake Superior to the sea.

*From paper read before the Ottawa Branch Canadian Society of Civil Engineers, March 15, 1917.

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(3) By establishing special damage courts to settle inundation claims.

(4) By constructing ideal developments at each concentration of fall, the energy to be transmitted and sold for specific purposes—transport, chemical reduction and manufacturing—possibly in the distant future for heat.

A proposed concentration is as follows:—

	Horse-power.
(1) Soo, 18-ft. fall	80,000
(2) Detroit regulation dam and lock	30,000
(3) Niagara and other passes	2,000,000
(4) Whirlpool	2,000,000
(5) Iroquois	290,000
(6) Morrisburg	190,000
(7) Cornwall	700,000
(8) Coteau Fort	255,000
(9) Cedars	500,000
(10) Cascades	190,000
(11) Lachine	380,000
(12) Montreal	315,000
	6,930,000

Turning now to the Ottawa valley, which is 55,000 square miles, about one-tenth of the whole St. Lawrence valley, the main stream could be concentrated as follows:—

	Horse-power.
Above Quinze only rough information	125,000
Quinze	200,000
Temiskaming to Mattawa	140,000
Dieux Rivieres	50,000
Rocher Capitain	100,000
Des Joachims	65,000
Paquette	35,000
Calumet and Rocher Fendu	100,000
Cheneaux	70,000
Chats	125,000
Chaudiere	165,000
Greece Pointe	80,000
Carillon	165,000
Back River	150,000
	1,570,000

Dealing with the St. Lawrence and Ottawa Rivers alone and west of Montreal only, there might be developed:—

On St. Lawrence, six millions horse power, half Canadian, half American.

On Ottawa, one and a half millions horse-power, all Canadian.

It would cost half a million dollars to concentrate the St. Lawrence and over a hundred million to concentrate the falls on the Ottawa.

Navigation is carried on for six months each year. Upon the St. Lawrence it approximates eighty million tons between Lakes Superior and Erie. Of this, 80 per cent. is American coal and iron between Pittsburg and Duluth, which will never go farther east. Between Niagara and Montreal the navigation dwindles down to only 3 per cent. of the upper lake traffic. From the port of Montreal about two million tons are carried out to sea each summer. The sudden drop in tonnage between Niagara and Montreal is due partly to the half-year of winter and partly to the small amount of rough freight from the west to Montreal. When the Hudson Bay route is in operation the tonnage to Montreal will be still less. Navigation is thus becoming of entirely secondary importance to power on the St. Lawrence above Montreal and no navigation of consequence has ever existed upon the Ottawa. Between Niagara and Montreal power must now replace navigation as an international concern. There is a clear three million horse-power for each nation on the St. Lawrence and an additional million and a half for Canada alone on the Ottawa. This paper is not concerned with powers on the tributaries of the Ottawa and St. Lawrence; they are left to the promoter and the financial juggler.

When Cartier came to Montreal Island in 1535 he had to row up from Quebec, because even his little schooners were, as the rivermen say, "too long in the legs." Champlain did likewise, and so did everyone else until 1840. Then John Kennedy got to work and now there is a submerged canal from Montreal down, giving 35 feet draught. Currents yet exist, however, and a ship is always in peril of running on to the edge of the dredged channel or colliding with other ships. The improved channel is also lowering the surface and reducing the depth. Here, then, is another chance for a dam, and a big one—a rock-fill of sixty-six million cubic yards, with regulation sluices capable of passing 750,000 cubic feet second. The experience on the Winnipeg River for the past twenty years and on the Ottawa for the past five years shows that the rock-fill type actually becomes a part of the geology of the country.

The dam proposed would preferably be at Tadousac, 100 miles below Quebec. There would be a twin lock of Panama Canal size lifting up to the slack water pond extending 270 miles to Montreal. The pond surface would be slightly above the high tide level and be controlled by regulation sluiceways of ample size to ensure discharge between tides without currents over three miles per hour.

The new surface curve from Tadousac to Montreal would, of course, flood property, and a special damage court, as mentioned previously, is required to settle claims.

The channel to Montreal will at once be made forty feet deep and over and the danger of currents overcome. In winter surface ice alone without frazil would be formed. This on a slack water reach could be broken in March, so that the port of Montreal would be opened a month earlier.

The slack water reaches above Montreal would prevent the formation of frazil to drift down to Lake St. Louis and the harbor. A ship arriving at Montreal would not have to contend with river currents while docking.

There might, when the business of the water powers demand it, be a ship route by Lake St. Louis, Lake of Two Mountains and the Ottawa River to Hawkesbury, thence across country by the valley of the South Nation to the foot of Lake Ontario, near Cardinal. This would be an interior route and allow of ocean boats reaching Ottawa city, and eventually power sites farther west on the Ottawa as well as those on the St. Lawrence.

The concentration of falls on the St. Lawrence, especially between Prescott and Lachine, would adversely affect the steamship tourist business. Steel chutes at each dam, however, are quite possible to build, and down these a steamer load of tourists will experience all the necessary thrills.

The Whirlpool dam below Niagara Falls, proposed by Dr. T. Kennard Thomson, of New York, will extend this tourist route up to the very foot of the falls themselves, while an additional two million horse-power will be available for the general public.

Niagara Falls have been the constant care of hysterically artistic amateurs of both sexes for many moons. At present my friend, Mr. Isham Randolph, of Chicago, sleeps uneasily and dreams that in a few centuries the magnificent curtain will have become a decrepit rapid, trickling through crevices or gurgling down gopher holes —"unwept, uncoffined and unsung."

Now, why not divert all the water into power that tends to ruin the venerable escarpment, replacing it by a cupid breathing spray from perforated pipes led around the crest? Even the outline of the Indian maid with her white canoe could be produced, and in wintry nights it could be electrically heated or shut off altogether.

Anyway, the possibilities of joint ownership and development by two nations of the greatest power centre in the world have been outlined. It may be assailed as a flight of imagination—well, so was the electric light, the telephone, a few decades gone by. Two generations will accomplish this ideal for the world's greatest valley.

ROAD CONSTRUCTION.*

By M. A. Lyons,
Chief Engineer, Good Roads Board, Manitoba.

In presenting the subject of road construction for your consideration it is not my intention to go into details, but rather to ascertain what basic principles the ratepayers and councillors must follow in order to obtain the best results from money expended.

While it is essential to give careful consideration to the economic and financial questions of road building, those are only subsidiary to the actual construction. It is possible to have good roads without good financing, but it is not possible to have good roads without proper methods of building them. The construction of the road is then the object of the other considerations, and it is in construction that money is spent. It is, therefore, necessary to investigate the fundamental principles governing this subject.

There are three elementary principles underlying economical and efficient construction. The first is the proper planning of the work so that necessary provision is made for drainage, the best alignment is selected, the economical grades established, and the proper shape of the road decided on. These matters come under the principle of good engineering. The second is the selection of the men, teams and machinery to do the work, and, most important of all is this division, the selection of an experienced and competent foreman. These matters are embodied in the principle of organization. The third principle is the planning of how the work is to be carried out, at which point the work will be started, in which sequence it will be followed up, and whether or not the work will be continuous. These matters are included in the principle of system. The three principles, good engineering, good organization, and the systematic carrying out of the work are the vital elements in road construction.

First, the engineering side of construction. What bearing has engineering on proper road construction? Three essential requisites for construction of a good road are drainage, grade and alignment. Drainage, drainage, and more drainage, is the slogan of all road builders.

In rolling country or open soil the drainage may not be a difficult question, but in a level country with heavy soil it often becomes a most difficult problem. Here skilful engineering is required to obtain proper grades for the drainage ditches and to locate offtakes which will carry the water away from the road ditches to natural watercourses so that the road may dry quickly after rains or in the spring. The question of grade is also one requiring careful consideration. Not only grade reduction on steep hills, but also the grade through rolling and through level country. In level country the road will be constructed of material from the ditch. Very rarely is a country so level that the quantity of earth taken out of a ditch is the same at every point in the ditch. Some places there will be more earth than is required for the building of the road at that point and at other places not sufficient. Careful thought must be given to the disposal of this earth, whether it should be hauled from places of heavy cut to places of light cut or whether some of it should be wasted and earth borrowed at the light cuts. In rolling country, where little ditching is necessary, the grade must be so planned that the cut from the hills must just balance the fills up to an economical length of haul, which length of haul must be determined. In grade reduction on hills the problem is to establish the most economical grade. This grade will vary with the relation of the cost of the grade reduction to the amount and nature of the traffic. It will be dependent on the direction of heavy traffic, the type of road, or perhaps be governed by a ruling grade on some other portion of the road.

A proper alignment of the road is necessary, both for appearance and economy. In level country a well-aligned road grade and ditch has an appearance in keeping with a neat farmyard and farm buildings. On side hill work a change in alignment may make a considerable change in the grade of the road or in the cost of construction. In rolling country it is often found more economical to build a road around a hill than to build over the hill and thus reduce a heavy grade to a level or nearly level grade.

The shape of the road is also an important question to be decided. It must be wide enough to conveniently accommodate the traffic which will make use of it, but no wider than is necessary or the expense of maintenance will be too high. The width of the road will vary according to the class and amount of traffic. In general, an eighteen-foot road is the minimum width on which two lines of traffic can comfortably pass, especially if some of this traffic is fast moving. On reads where the traffic is light and slow moving a sixteen-foot road may suffice.

The location and size of ditches must also be given consideration. The ditches must be so planned and constructed that the road will be safe for traffic. The location, size and shape of the ditch will vary with the class of road, with the nature of the soil and with the topography of the country. The crown of the road must be such that any water falling on it can quickly find its way to the ditch. But the crown must be no more than is necessary to serve this purpose. The amount of crown will vary with the type of road, with the grade of the road and with the character of the soil.

From these considerations it is apparent that engineering plays a very important and essential part in road construction.

The part which the organization has in road-making is also very important. It is useless to plan proper drains, grades, road sections and alignment unless the construc-

*Abstract of paper read before the Manitoba Good Roads Association.

tion of these is properly carried out. It is also necessary to carry this work out in the most economical way, as it is here that a lot of money spent in building roads is utterly wasted. A good organization requires the use of tools and machinery suitable for the type and amount of road which is being built. A slip scraper where necessary and a wheel scraper where it is necessary, a push grader in its proper place and an elevator grader in its place; team hauling of material where that is economical and hauling by tractors where these prove economical. Each of these have their place, and a proper organization will use each in its right place. The number of teams and men must suit the requirements of the road under construction. Too many men and teams, and they will be in each other's way. Too few, and the work will not be carried out economically. Most important of all is a good foreman, who knows what is required and how to get the desired results. Under a good foreman every team and every man is in the right place.

Under proper organization the men soon discover how each portion of the work can be most easily carried out and just what work should be done. No time is wasted getting started and no unnecessary labor performed when they are at work. A man on work with which he is familiar will certainly show better results than one unaccustomed to that work. The effect of this knowledge will be shown in a lowered cost and a better job of construction. Good organization, therefore, not only insures that the road will be properly constructed, but that it will be economically constructed.

The third principle of proper road construction is the systematic carrying out of the work. For the best results the whole road scheme should be planned in advance and every piece of work done towards the completion of that scheme. It is not meant by this that every piece of road on which work is done should be at once constructed as a finished road, as financial conditions will not always allow this, but whatever work is done should be a step towards the completion of the finished road. This systematic construction is very important where drainage is necessary. The only proper place to start a road drain is at its outlet and the work carried towards its upper end. The mile of road which is most used is the one next to the market. It is, therefore, reasonable that the roads nearest the market should be built up first and the system added to each year as far as possible. It is only by this systematic carrying out of road construction that a satisfactory scheme of roads will ever be provided.

These three principles, then, engineering, organization and a systematic scheme of road-building are the three essential elements for road construction. If these are attended to good roads will result.

An exemplification of the results of adopting correct principles for road construction is seen in England. This country, after struggling in mud for fourteen hundred years, applied these principles which we have just considered under the supervision of John MacAdam. From that time onward England's roads rapidly developed. Shortly after this, England also began to develop industrially. With the experience of our Mother Country before us as well as the experience of other countries, we must be classed as dull children in this respect if we do not adopt these fundamental principles in our road construction. All ratepayers will not be building roads, but all can use their influence to have road construction in their municipality carried out under proper engineering, good organization and in a systematic manner.

PLANNING THE DISTRIBUTION OF THE WATER SUPPLY OF A SMALL TOWN.*

By M'Kean Maffitt,
Superintendent Water and Sewers, Florence, S.C.

Having determined the necessary supply, storage and filtration of the new water system, it becomes necessary to take up the distribution of the supply. The term "distribution" covers all the operations of the plant from the filtered or clear water reservoir up to the point where the water is delivered to the consumer.

The Method of Distribution.—Distribution of supply is one of two main kinds, gravity or pumping; in rare cases both gravity and pumping are resorted to. Where the topography is suitable a purely gravity supply can often be developed that will need neither purification nor pumping. In cases of this kind, there are but few points as to capacity of supply and distribution to be considered. However, in most cases it is necessary either to purify or to pump the water, or both. In some cases there is a combination of direct pumping to reservoir and gravity distribution from the reservoir to the consumer. These conditions favor the most economical rate of pumping, provided the reservoir can be made of sufficient size to accommodate all variations in demand, and is high enough to give sufficient pressure for all fire and domestic purposes.

Where the reservoir site is of the above nature, the pumps can be designed for a nearly constant speed and for a constant head, and neither will materially change except as there are changes in the water level in the reservoir, and these changes will be seasonal rather than daily or weekly. Pumps designed for such conditions can be operated at a much more economical load than can pumps that are designed to operate part of the time at one speed and head and part of the time at another speed and head. Such conditions will be ideal from an operating point of view, and the only objection to them is that there may be a rather high capital charge for the installation. This should be carefully watched to be sure that what is saved at one place is not lost at another. Locations such as this should be most carefully planned so that there will be sufficient capacity in the mains to and from the reservoir, especially from the reservoir. Particular attention should be paid to the size of the outlet, lest it be too small for the supply, as it will have to work under a very little head of water and its capacity will be governed thereby. Then there should be a duplicate main in the principal distribution system to prevent a water famine in case there is a failure in one main. The capital charges on this duplicate main may be very large, as the site of the reservoir may be at some distance from the city.

In case the reservoir site is upon the top or the side of a hill sufficient diamond drill borings should be made to determine the condition of the underlying strata. Do not think that because it is a hill it is as strong as the hills. There may be an underlying stratum that will be of insufficient strength to carry the additional load imposed upon it by the erection of a reservoir on its top. Or leaks may develop in the reservoir that will so saturate the underlying strata that they will become too unstable to carry the load. These points may seem far-fetched or unreasonable, yet they are possibilities and grave ones, and must be investigated. In any case, the design of a gravity system should be such that it will be as easily controlled as a pumping system.

*From "The American City."

If the topography is not suitable for a gravity system, there remains only the pumping system. Knowing the greatest quantity of water necessary for all purposes, design the pumping equipment with two or more units for the care of the maximum demand at normal speed and rated load. Then one unit can care for all domestic consumption and most of the smaller fires, and the other unit can be held in reserve for large fires and as a relief unit. In case of extra heavy loads for short periods, both units can be operated at a considerable overload for such emergencies. Under no conditions depend on single units in any part of the system where it is possible to install duplicates or more.

Selecting the Pumps.—The selection of type or design of pumps is so dependent upon operation conditions and power supply that it is possible only to mention here the different types, such as: direct-acting plunger pumps, steam, electrical or belt-driven; centrifugal pumps, steam, electrical or belt-driven. Each type has its advantages and its disadvantages, and local conditions of supply and demand and power supply will govern selection of type. In general, it may be said that in any type of piston pump, slow speed and long stroke should be the objects sought, as they are the more satisfactory from an operating point of view. In centrifugal pumps, not too high speed and as near as possible a constant head discharge are the desirable conditions. Too great speed causes too great friction in the pump and accentuates erosion in case there happens to be the least sediment in the water. Too irregular head lowers the efficiency curve of the pump, thereby losing overall efficiency in the plant. This, however, may be offset by the other advantages of the centrifugal pump.

The three main sources of power are steam, central station current and internal combustion engines. Here again local conditions will govern the selection of the type of power plant. Where coal is high and hard to get, with a reasonable oil rate, there may be great advantage in adopting an oil engine main drive and electric sub-drives throughout the plant. Where there are large, well-regulated central stations giving first-class service at reasonable rates, there may be advantage in central station current. Where coal is cheap and deliveries are good, then steam may be the cheapest and the best power to be had.

In any case there must be break-down or reserve service. Central station current will require steam or oil engine reserve. Oil engines will have to be in duplicate and steam will have to have duplicate equipment. With regular central station service there is the great danger of allowing the reserve plant to get in bad shape, especially in the smaller cities. This should never be countenanced, and to be sure that there is a reserve plant ready at all times the steam plant should be run at least one week in every month. No operating engineer can lay by a steam or oil engine plant for thirty, sixty or ninety days and be sure that it will operate successfully at a moment's notice, and that is all the notice that one gets from central station service, even if that much. The writer is of the opinion that with properly designed boiler settings, engines and auxiliaries and with coal at not over $4 per ton, there is small chance for the central station to carry the load at its commercial rates. If current costs less than one cent per k.w.h., there may be reason for trying the central station current.

There are the usual charges against whatever power adopted, such as interest, depreciation, operating repairs, replacement costs and general operation expense. In steam-driven pumps there are the items of valves, packings, lubricating oils, slippage, water hammer, attention, etc., that must not be overlooked. In centrifugal pumps, the items of valves, packings and lubricating oils can generally be ignored, as they are very small. Slippage also is a negligible quantity unless the water is gritty or acid or the excessive speed causes severe erosion of working parts. Each class of pump must bear its own load, and where there are necessary auxiliaries for any of the main units the operation and upkeep of these must be charged to the main unit in figuring the cost per 1,000 gallons pumped.

The Layout of the Mains.—The layout of the mains for the distribution of the water is governed mostly by the congestion of the buildings and the general direction of expansion, though the distances through which the mains have to be laid is an important factor. There have been so many cases where water plants have had to replace all small mains at great cost before the material in the lines had begun to deteriorate to any extent that it seems hardly necessary to call attention to this point, though the failure to provide against it in many cases may be caused by not giving it sufficient thought in the beginning. From the operator's point of view, mains can hardly be too large, whereas in general practice they are very seldom large enough for ordinary purposes. The difference in first cost is so little that there is no reason why they should be restricted in size. The following table, arranged by the writer for comparison purposes, when pipe and other supplies were normal, may throw a little light on the subject:—

Size main inches.	Cost foot.	Unit capacity.	Cost unit capacity.
4	$0.40	1	$0.40
6	0.60	2	0.30
8	0.80	4	0.20
10	1.00	6	0.16
12	1.50	9	0.16

The table shows that where a 4-inch main is run at a cost of 40 cents a foot the unit capacity is only one, whereas by doubling the cost per foot the unit capacity is quadrupled and the cost per unit of capacity is cut in half.

As far as the writer knows, there is no method or formula by which the proper size of main can be figured, and it is general practice to use the best judgment of the engineer or the superintendent to suggest proper sizes. This is entirely wrong; the sizes should be governed by the uses to which they are to be put. Cut the city into districts, segregate each district, calculate the maximum capacity demanded for each, and lay the mains of sufficient size to care for that demand. See that each district has feeders large enough to supply the demand, then tie all the districts together in gridiron fashion, and there will be small chance of the mains being too small. No matter if the investment is a little large at first, it will pay in the end to have mains that are large enough to stand the service and will not have to be torn out in a few years.

In the average residence section where the buildings are not congested to too great an extent and where there is a good gridiron lay-out of mains, the minimum size should be 8 inches and there should be much larger feeders, or belt lines that act as feeders. If the pressure happens to be very low and thereby calls for pumping units in the fire department, the minimum size should be 10 inches. A main of this size can generally be depended upon to furnish sufficient water in residence sections to meet all demands and not to limit the use of the water by the fire department to one or two hydrants when five or six are needed.

The Fire Hydrants.—The location of fire hydrants is a mooted question and should receive careful consideration. The general haphazard manner of locating a hydrant on each corner is like all the other hit-and-miss plans used. The best practice is to so lay out the hydrants that there will be one hydrant within a predetermined distance of any building that is to be protected. The writer believes in locating hydrants at least every 300 feet on all streets, and closer in the congested districts. In congested districts where there are great fire risks, hydrants should be not over 100 feet apart and located on alternate sides of the street. This will allow for one entire sidewalk to be blocked by falling buildings, and still have a hydrant every 200 feet on the other side of the street.

In normal times the cost of a good hydrant and branch line valve set up is not over $50 and the hydrant is good for at least twenty years, but with proper attention it will last as long as the mains last. Fire hose costs from 80 cents to $1.10 per foot and lasts about five years where not very much use is made of it, and proportionately less where it is used regularly. So the location of hydrants at closely spaced intervals will eliminate almost all long lines of fire hose and will materially reduce the fire department's expense for fire hose, to say nothing of being able to get the full benefit of the hydrant pressure on the hose.

In case the mains carry sufficient pressure for fire-fighting, the hydrants should have 6-inch or 8-inch connection to the mains and three or four regular 2½-inch openings or nozzles. Where the pressure is so low that the fire department has to repump the water, the hydrant should have not less than an 8-inch connection to the main and two or three 4-inch openings or nozzles. These conditions will allow the fire department to concentrate several streams on one fire and have no very long lines of hose on any of them.

The Eureka Fire Hose Company has published a chart showing that for 250 gallons of water per minute from one 1⅛-inch nozzle with 200 feet of hose it requires only 55 pounds hydrant pressure, whereas with 600 feet of hose it requires 95 pounds hydrant pressure, and with 1,500 feet of hose it requires 195 pounds hydrant pressure for the same amount of water. This shows that the closer spaced hydrants are the most advantageous as well as the most economical.

In selecting the type of fire hydrant, first cost should be the last consideration. Ease of operation, delivery capacity, accessibility of parts for repairs, low liability of breakage, and rugged construction should be the main features in any type. All types, however, should open against the pressure where it is possible. In case there is liability of heavy increase of pressure, this is an important factor in the hydrant, as small leaks under normal pressure become dangerous leaks under increased pressure when the hydrant valve opens with the flow of water. In any case, a gate valve should be placed on the branch line to the hydrant so that there may be no need of cutting out a whole block or section to make repairs to one hydrant.

Laying the Service Lines.—In the service layout of the plant great care should be taken to see that the pipe lines are properly laid and that there are no chances for them to be broken off at the main by the settlement of either the main or the branch line. Also, a good and strong curb cock or cut-off should be placed at the curb line, so that there will be a place at which the service can be controlled. In selecting the material for the service lines, it must be borne in mind that the line is put there for a permanent improvement and not as a temporary fixture. Too many engineers and superintendents reason that there is small chance for the use of the curb cut-off and that therefore it may be of a cheap design. This is wrong, especially in view of the very fact that it may lie idle for such a long time. After a long time out of use, unless it be of the very best, it will invariably give trouble when put in use again.

No service on any water plant should be without the proper measuring device where it enters the property, no matter if the supply of water be unlimited and there be no apparent chance of ever using all of it. Water should be sold for use and not for waste, and the only way to sell it for use is to make those that get it pay for it. Then if they want to waste it they can waste it, but they will pay for it just the same. With no meters and with flat rates for consumers, there is great danger that the service fixtures may leak badly and put such a drain on the mains that there will be small capacity for the fighting of fires. Ellis says that a circular orifice one-sixteenth of an inch in diameter working under 50 pounds pressure per square inch will deliver 1,180 gallons of water per day. So in case there be 1,000 consumers who have no meters and only one one-sixteenth-inch leak each, it will require 1,180,000 gallons of water per day for that waste.

SUGGESTED NEW DOCK SITE FOR ST. JOHN, NEW BRUNSWICK.

Mr. William Murdock, city engineer of St. John, N.B., in his annual report just issued, makes some very important suggestions in connection with improvements to the docking facilities of the harbor there. He suggests that a new dock site be built at Rodney Slip and extend 2,000 feet, reaching the upper end of Navy Island.

He refers to it as "a dock site which commends itself highly among the possibilities of St. John harbor, as being well in from storms, entirely free from ice and strong currents, would give 3,800 lineal feet of wharf front, and be centrally situated on the line of the proposed harbor bridge. Borings have shown that such a wharf could have thirty-five feet in depth of water, along the entire front named, without excavating rock. The greater part or all of the material removed could be deposited by suction dredges on the land between Navy Island and the northern end of the wharf. Two thousand feet of continuous frontage would be available on the eastern side, 1,500 feet on the western side, and 300 feet across the southern end. The northern end would be exposed to the strong river currents and, perhaps, not be desirable. The railway track on Union Street West, could be extended northward, eastward and southward via Middle and Nelson Streets and the ledge which connects the island with Carleton at low water. Here a trestle would be advisable that the tide could flow west of Navy Island as it does at present.

"Such a wharf would require removal of the ferry dock, which could be changed at a minimum expense to the head of Rodney Slip, as shown on the plan. The tramway down South Rodney Wharf would be discontinued and the wharf restored for shipping as of yore, thus liberating to the small craft a frontage of about 1,000 feet, whilst Nelson, Wellington and King Street slips would be available as now."

HIGHWAY TRAFFIC ANALYSIS AND TRAFFIC CENSUS PROCEDURE.*

By William H. Connell,
Chief, Bureau of Highways and Street Cleaning,
Philadelphia, Pa.

WITH traffic increasing at such an alarming rate, the street traffic problem, both with reference to the varying widths of streets and the wear and tear on the pavements, is one of the most serious ones the engineer has to contend with to-day.

With the present rate of increase, before very long it will be necessary to designate certain north and south and east and west streets for passenger traffic, and other ones for the business traffic, consisting of delivery wagons and trucks, both automobile and horse-drawn.

The number of automobiles in the city of Philadelphia in 1912 was less than 9,000; in 1914 nearly 17,000, while to-day there are over 35,000, or about four times the number there were in 1912, and twice as many as in 1914, and the traffic is from three to five times as heavy on a number of our main automobile thoroughfares as it was in 1914, and there is no reason why we should not expect traffic to practically double in the next two years, as the maximum will not be reached for some years. The cost of automobiles will gradually decrease, and in like proportion the number will increase. They are no longer a luxury, but more or less of a necessity. All the people are waiting for is a lower first cost, and a cheaper fuel, both of which are in store for the future.

Though the fundamental purpose of a highway is to carry surface traffic, the lack of foresight, due largely to the absence of studies relative to future traffic considerations, has resulted to a considerable extent in the conditions existing in most municipalities to-day where both the general plans and widths of many highways and the characters of their pavements are largely or entirely inconsistent with the traffic requirements to which the highway is subjected. Traffic planning is a problem in itself. Its purposes should be to develop closer and more consistent relations between probable traffic requirements and existing and proposed traffic provisions.

The operations constituting the general function of traffic study may be properly sub-divided into two general classifications as governed by the purposes and nature of the data to be obtained and of the methods of investigation involved.

Traffic Survey, which has to do with the investigation of the physical and other conditions influencing or relating to the carrying of proposed or existing highway traffic.

Traffic Census, which has to do with investigation of the quantity, character, weights and other conditions of traffic.

A system of traffic study, to be complete and comprehensive, should provide ample data for a full consideration of the following features:—

The Plan of the Highway: Including the consideration of the use of curved, rectangular or diagonal lines, and of the necessity and location of traffic circuit highways; the determination of the grade; the number and desirable width of the roadways and footways to accommodate present and probable future traffic requirements; and the possibility of devoting certain spaces to the purposes of temporary or permanent lawn or planting areas.

The Design of the Pavement: Including the advisability of improving the full legal width of the roadway and footways, and the selection of the types of pavement surfaces and base course construction best suited to the requirements of the prevailing traffic.

The Maintenance of the Pavements: Including the study of the depreciation and maintenance costs per unit of traffic and of the physical effects of traffic upon the pavement surfaces with respect to total and unit vehicle loads, width and character of tires, speed, and non-skidding and braking devices.

The Cleaning of Highways: Including the determination of the kind of cleaning best suited to the existing type of pavement and the prevailing character of traffic and of the hours during which the cleaning may be performed with the least interference or inconvenience to traffic.

Traffic Regulations: Including the assignment of definite highways for specific classes and directions of traffic; the designation of parking areas for automobiles and other vehicles; the establishment of pedestrian crossings and safety islands and zones; the determination of the most suitable location for proposed street railway tracks and the consideration of the advisability of relocating existing tracks; and the establishment of a general system of control by signal devices or otherwise to insure safety and to eliminate entirely or reduce to a minimum the congestion of both vehicular and pedestrian traffic.

Traffic Units.—Like many other engineering determinations, no standard methods have been universally adopted for the classification of traffic; for the taking of traffic census data; or for the reduction of the census data to definite units. While most traffic censuses are conducted along the same general principles, yet the absence of a uniformity of details and especially of a generally recognized standard traffic unit has confined the value of most traffic census data largely to the purposes of local comparison. The character of the data should, nevertheless, be such as to permit it, in addition to being used for local comparative purposes, being also studied in connection with data taken in similar situations in other localities.

In most traffic censuses conducted thus far, it has been the general practice to consider as a proper traffic unit the value expressed by the term "ton of traffic per foot width of pavement," which is based upon the total load passing over the entire width of the pavement in a measured period of time. This is misleading, and practically worthless, as a factor to be used in connection with the designing of a suitable type of pavement, due to the fact that in most cases only a relatively small portion of the width of a roadway carries the maximum traffic load, while the remainder carries comparatively little traffic.

A pavement to be used in any specific situation must, of course, be practically of a uniform character of material and this makes it all the more necessary that the selected type of pavement be capable of performing satisfactory service at the point of maximum wear which necessarily lies within the maximum travelled width of the pavement and especially in the tire paths.

The segregation of moving traffic is due to several causes, principal among which may be included the parking of vehicles along the curbs or in the centre of highways, and the presence or absence of railway tracks.

It is obvious, therefore, that the maximum travelled width or that width of the roadway subjected to moving traffic rarely equals the total width of the roadway. In each case, however, the approximate travelled width

*Abstract of paper read before the American Association for the Advancement of Science.

should be carefully investigated. In most cases it will be found to vary only between one and two times the average width of the prevailing type of vehicle, and in many other cases between one and several times the average width of each of the tire paths. The logical necessity for the consideration of the "maximum travelled width" in preference to the "entire width" of a roadway will be fully justified when it is considered that the unit "average tonnage per foot width of roadway" will give values far less than those given by the unit "average tonnage per foot of maximum travelled width of roadway."

For the purpose of the selection of a satisfactory type of roadway pavement for any given situation, it is also very necessary that the annual maintenance and the life cost (depreciation and interest on first cost) of the type of pavement under consideration per unit of traffic be known with some degree of certainty.

The most logical and satisfactory unit of traffic measurement yet proposed would seem to be the "ton-mile" or its multiples, such as "hundred-ton-mile," or "thousand-ton-mile." To obtain the actual ton-mile of traffic, the census figures that represent the maximum load should be reduced proportionately to give the average load.

The use of the "ton-mile" unit will not alter or render more difficult the general methods employed in the taking of traffic census data. It is only necessary that the observer be stationed in a block or stretch of highway of known length where every vehicle in passing the observation point must actually traverse a definite fractional part of a mile length of highway.

For the purpose of local comparison, it is seldom necessary to use more than one kind of traffic unit, but when it is desirable to provide data that may be compared with studies made in similar situations in other communities, any additional kinds of units that may be necessary should be used in order that the data may be reduced to comparable form.

Classification of Traffic.—As governed by the weights of vehicles and the characters of their tires, vehicular traffic should be divided into as many classifications as may be necessary to give fairly accurate results. In general, however, fourteen somewhat standard classifications have been proposed, which, while more or less arbitrary in determination, are nevertheless considered to be fairly representative of average traffic values. These several classifications are as follows:

Classification. Character of traffic.	Average weight in short tons.
Horse-drawn—	
(1) Horse without vehicle	.65
(2) Light one-horse-drawn vehicle	1.20
(3) Heavy one-horse-drawn vehicle	2.00
(4) Light two-horse-drawn vehicle	2.00
(5) Heavy two-horse-drawn vehicle	4.00
(6) Three-horse-drawn vehicle	5.00
(7) Four-horse-drawn vehicle	6.00
Motor-driven—	
(8) Motorcycle or bicycle	.15
(9) Two-passenger motor vehicle	1.30
(10) Over two-passenger motor vehicle	2.30
(11) Light freight motor truck	3.30
(12) Medium freight motor truck	6.00
(13) Heavy freight motor truck	8.50
Miscellaneous—	
(14) Miscellaneous extra heavy traffic	As individually estimated

The terms "light," "medium" and "heavy," as used in these traffic classifications, are intended to indicate the maximum possible capacity of the vehicle and not the relative weight value of the load carried at the time of its observation. These classifications of traffic are only intended to serve for general purposes.

In determining the probable compressive, shearing and impact stresses produced in the pavement it will be necessary also to determine the maximum unit weights carried per inch effective width of tire. In this connection it should be noted that the several characters of tires in general use include both metal and smooth surfaced and non-skidding rubber tires of both the solid type and of the inflated type, and also caterpillar solid rubber tires and tires equipped with non-skidding devices.

Analysis of Traffic Census Data.—The data compiled from a systematic census count taken each year as being representative of the average traffic conditions prevailing throughout the year makes it possible to estimate very closely the total probable tonnage carried during the entire year. This data, when considered in conjunction with the records of the total annual charges for depreciation and interest on first cost and maintenance costs and the average travelled widths of the pavements, will give the following analysis:

Traffic tonnage—
- (*a*) Total tons of traffic per year carried by the highway.
- (*b*) Average tons of traffic per year per foot width of roadway pavement.
- (*c*) Average tons of traffic per year per foot of maximum travelled width of roadway pavement.
- (*d*) Total tonnage for life of pavement per foot width of roadway.
- (*e*) Total tonnage for life of pavement per foot of maximum travelled width.

Ton-mile maintenance costs—
- (*f*) Annual charges for depreciation and maintenance cost per ton-mile of traffic.
- (*g*) Total charges for depreciation and maintenance cost per ton-mile for life of pavement.
- (*h*) Average ton-mile of traffic per 1 cent of charges for average annual cost of pavement.

This data will show definitely the relations that actually exist between the traffic service and the depreciation and the maintenance costs of the pavement, which constitutes a most important factor to be considered in the selection of a type of pavement.

In 1913 seventeen of the largest water consumers of Johnstown, N.Y., who were in the business of leather dressing, used a total of 49,846,215 gal. of water for that year, compared with its use during the year 1916 of 260,468,087 gal., or an increase of 366 per cent. These seventeen services use one-third of the total water from the city's three sources of continuous supply.

Steel bars, plates and shapes have never sold higher in the history of the trade than the prices reported from Pittsburg as put into effect recently by the Carnegie Steel Co. Plates were advanced $15 a ton. Bars and shapes were put up $7 a ton, making the quotations 3.35 cents a pound for bars and 3.75 cents for shapes. On March 12th wire products were lifted $4 a ton, the entire development supplying the most spectacular week, so far as prices are concerned, since the current boom got under way. The enormous demand for ship plates from the yards at home and abroad has been the dominant factor in the plate price increase, and structural shapes have also been affected by the expanding shipbuilding industry.

THE LAYING OUT OF STREETS AND BOULEVARDS IN RELATION TO MODERN TOWN PLANNING.

By L. McLaren Hunter, C.E.,
City Engineer's Office, Ottawa.

AFTER the present war has finished vast sums of money will likely be expended on town and city planning in Canada. New towns will probably spring into existence, and in most cases the widening and the laying out of new streets and boulevards will be of the first importance. Mistakes which have been made in the past, especially in Eastern Canada, of laying out long and narrow streets, will not, probably, be made in the future.

Before dealing expressly with street design, it might be permissible to mention a few details which must not be overlooked in the planning of a modern city.

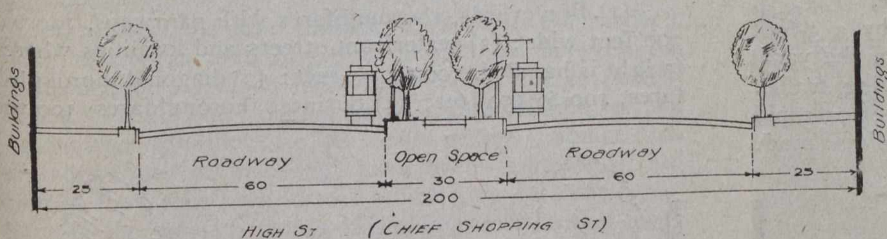


Fig. 1.

Every town or city will have its distinctive feature which will predominate the whole design. In a Capitol, the houses of parliament, and in most other cities the city hall will predominate. The social, civic and industrial

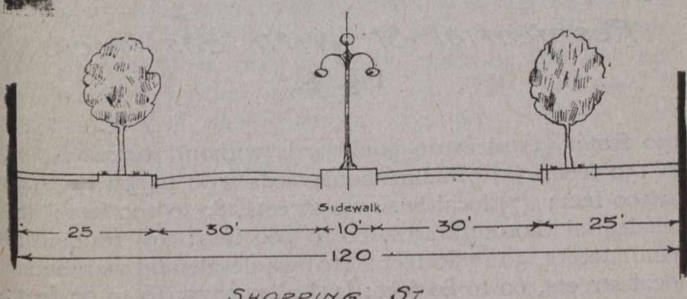


Fig. 2.

characteristics, along with the topographical character, have to be given their proper place in the design.

The first consideration is the health of the citizens; therefore in planning, proper provision must be made for an adequate water supply; secondly, a good sewerage and drainage system is necessary. The other essentials required are, proper scavenging and removal and disposal of house refuse. The construction of business and residential thoroughfares, boulevards and bridges, street railway system, gas and electricity for lighting and power; parks; recreation grounds and open spaces; architectural treatment of all public, industrial and residential buildings.

The first plan to be prepared should show all the natural features, such as woods, trees, rivers and hills; this plan should also have the contour lines marked upon it. Then we proceed to locate the different areas—government, civic commercial, industrial and residential.

The commercial area is usually placed between the civic and residential areas; the residential area, of course, occupying the outskirts of the city.

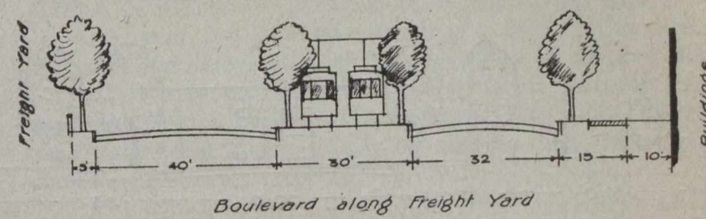


Fig. 3.

The location of industrial areas requires considerable study. The proximity to railways or canals has to be taken into consideration. This area must be located so that the prevailing winds will carry the smoke away from the shopping, civic and government centres.

The designing and laying out of the main thoroughfares and boulevards is a most important part of the modern city, for the beauty of a city entirely depends upon the laying out of its streets, boulevards, bridges and parks. The direction of the streets has to be studied, so that a view of the principal buildings may be obtained. Careful consideration has also to be given to the widths and grades, and in the plan, squares and crescents have to receive treatment.

In the business sections of a city the streets should be wide and direct, and it is essential that an easy grade is obtained. Fig. 1 shows the layout of the High Street (a chief shopping street) of the new federal capitol of Australia. This street is 200 feet wide, having 25-foot sidewalks on each side and two 50-foot roadways (on which the car tracks are placed). In the centre is a 30-foot plot of ground where two lines of shade trees are placed. This plot serves the double purpose of allowing passengers from the street cars to alight in safety, and also provides a cool resting place for tired shoppers.

This thoroughfare is almost ideal in layout but, unfortunately, few cities in Canada have the same opportunity as the capitol of Australia, where the land all belongs to the government, and where the sale of lots for building purposes will amply repay the government for the construction of wide streets and boulevards.

In Fig. 2 is shown a secondary shopping street of

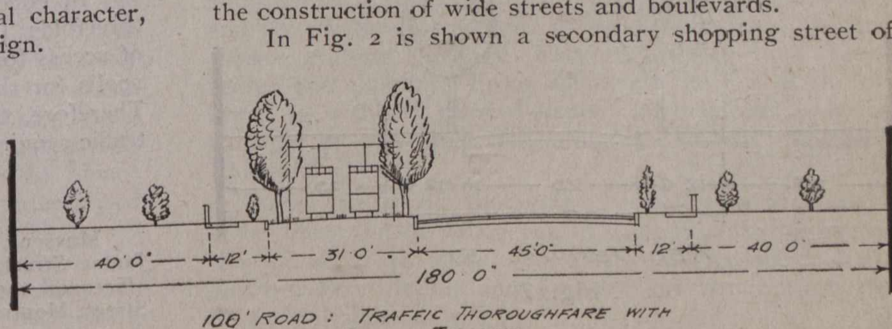


Fig. 4.

the Australian capitol. It is laid out on the same principle as the High Street, but is only 120 feet wide and has no car tracks. There are two roadways 30 feet wide with a 10-foot central sidewalk. On this sidewalk ornamental posts are placed for street lights. There is a space of 25 feet allowed between the roads and the buildings, which is used for sidewalks and shade trees.

Industrial streets, or streets where heavy freight has to be handled, have to be treated in a different manner. The grades must be easy and allowance made for slow and rapid transit. In Folwell's "Municipal Engineering Practice" a good street layout is given where the freight yard is on one side and buildings on the other (Fig. 3). The side next the freight yard is taken up by a 5-foot strip with trees (to close the unsightly view of the yard) and a 40-foot allowance for heavy, slow-moving traffic. On the other side there is a 32-foot allowance for rapid transit and 25 feet between that and the buildings made up of a 5-foot space for shade trees; 10 feet of sidewalk, and a 10-foot allowance for street cars with shade trees. Altogether giving a very pleasing appearance.

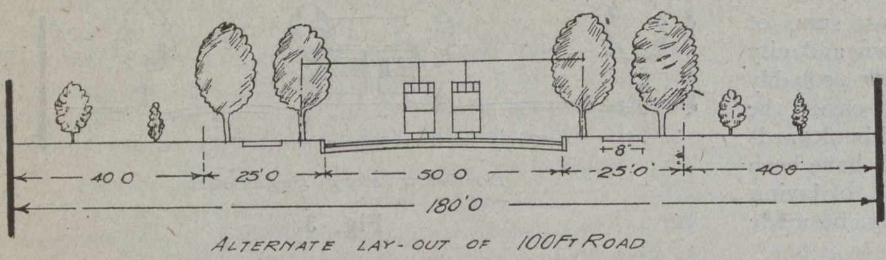


Fig. 5.

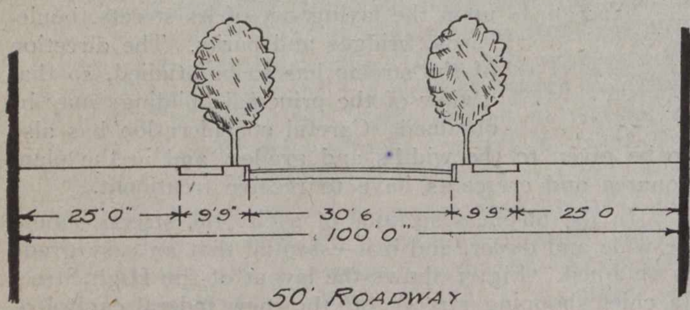


Fig. 6.

In dealing with residential areas, the methods used in planning should be entirely different from the business districts where rectangular and radiating systems are most suitable. Beauty in layout and economy in construction of residential streets should always be the rule.

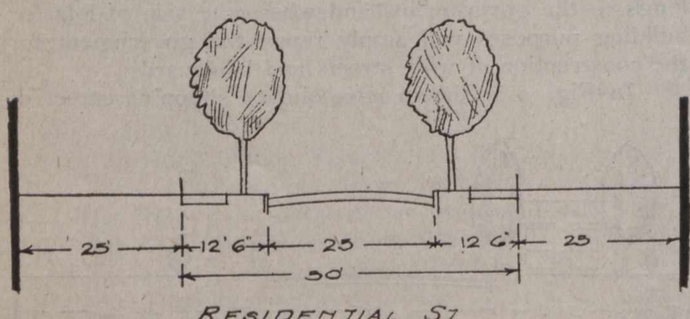


Fig. 7.

Circular, irregular and undulating boulevards give the most pleasing results.

In Figs. 4 and 5 alternate designs are shown for the layout of residential traffic thoroughfares with car tracks. These are the types permitted under the town-planning scheme of Great Yarmouth, England. The street is 100 feet wide, with 40-foot set-backs (or parterres) to the buildings. In Fig. 4 the track allowance of 31 feet is separated from the roadway by trees.

Fig. 6 shows an ordinary residential street (Great Yarmouth, England) 50 feet wide, made up of 30-foot 6-inch roadway, 9-foot 9-inch allowance for sidewalk and boulevard, with 25-foot set-back.

The Australian capitol has practically adopted the English layout for residential streets. Fig. 7 shows a section of a 50-foot road as planned for Australia. The roadway is made 25 feet wide.

Fig. 8 shows the American method of dealing with a residential street with car tracks, in the centre, 17-foot roads are shown on each side of the tracks for vehicular traffic.

In Folwell's "Municipal Engineering" the following widths are given as the standard for streets and boulevards:—

(1) Boulevards, thoroughfares with parkways, 150 to 300 feet wide; (2) waterfront streets and localities where freight is handled, 100 to 250 feet; (3) diagonal thoroughfares, 100 to 150 feet; (4) business thoroughfares, 100 to 150 feet; (5) pleasure boulevards without parkways, 75 to 150 feet; (6) pleasure boulevards with parkways, 150 to 500 feet; (7) local business streets, 80 to 100 feet; (8) residential thoroughfares, 80 to 100 feet; (9) residential local streets, 50 to 80 feet; (10) wholesale and warehouse local streets, 60 to 80 feet; (11) alleyways, 10 to 20 feet; (12) residential and business lanes, 5 to 25 feet respectively.

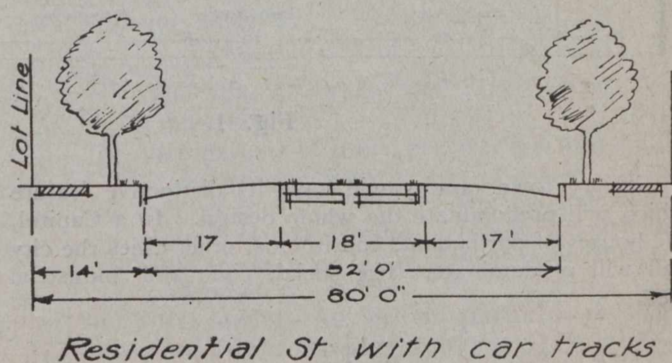


Fig. 8.

In conclusion, the general functions of streets are threefold: (1) They act as thoroughfares; (2) as a means of access for property fronting on them, and (3) as open spalls for the admission of light and air to buildings. Therefore, the width must be mainly governed by the traffic requirements and the size of buildings.

Mussens Limited, of Montreal, have removed from 318 St. James Street, Montreal, and are now occupying their new offices on the 2nd floor of the McGill Building, 211 McGill Street, Montreal.

Plans for what is expected to be the tallest building in the world—57 stories—to cost $15,000,000, and capable of accommodating 10,000 people, have just been prepared by a Detroit architect for the Exhedra Corporation. Options have been obtained on a $5,000,000 site, bounded by Michigan and Cass Avenues, Lafayette Boulevard and First and Abbott Streets, Detroit, and tentative tenders have been called for. The plans call for a 27-story hotel and 57 stories of offices, running up into a tower 808 feet high.

COMPLETION OF A TRANSCONTINENTAL LINE OF PRECISE LEVELS.

By F. B. Reid,
Supervisor of Levelling, Geodetic Survey of Canada.

THE driving of the last spike in a transcontinental line of railway has usually been marked by some sort of ceremony on the part of the builders. No formalities took place, however, in connection with the last "shot" on the Geodetic Survey's first complete line of precise levels from the Atlantic to the Pacific. This was taken at Port Arthur, Ont., on October 17th last and closed a gap of about 300 miles which had existed at the beginning of the season; a similar gap of about the same length had been closed only a few days before in British Columbia. The finishing of the above links gives an unbroken line from the automatic tide gauge at Halifax to the automatic tide gauge at Vancouver.

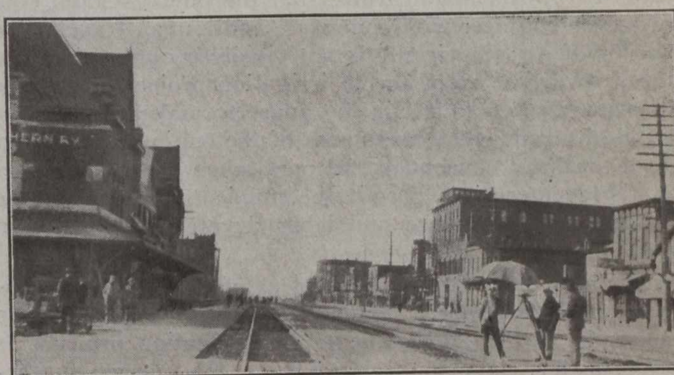
Doubtless the first question to arise in the reader's mind will be as to the agreement obtained between the instrumental levels and mean sea level at the respective coasts. This enquiry cannot be answered offhand for the reason that for about 40 per cent. of the distance two or more lines of levelling have been completed, and circuits have thus been formed which give different elevations to the junction points, depending upon which route is used. Some fifteen circuits occur directly along the transcontinental line, not counting a number of others lying at a greater or less distance from it.

The system of levels is not sufficiently advanced to justify making an adjustment to determine the most probable elevations by utilizing the various circuits; it has, therefore, been deemed the fairest way to carry the elevations along from coast to coast by using the shortest route in every case where there is a choice of routes. The shortest line may in some cases be the first one levelled and in other cases the last. This, however, is not a matter of importance, as the same methods have been followed throughout the work, and consequently the same "weight" may be assigned to all the levelling. In this respect the work of the Geodetic Survey of Canada, having all been done within comparatively recent years, differs from some of the other countries in which the geodetic levelling is composed of work done by methods differing one from another.

Starting with an elevation of zero for mean sea level at Halifax as determined by the officials of the Tidal and Current Survey, Department of the Naval Service, and carrying along the elevations continuously by the most direct route, the level of the Pacific ocean at Vancouver is found to be 1.17 feet. Supposing mean sea level to be the same on the two coasts, this difference may be set down to errors in the levelling. Since some 60 per cent. of the line has not been duplicated by a second line it may be that additional levelling will disclose errors that will increase this amount, or, on the other hand, will reduce it. However, as all levelling has been done twice (independently forward and backward), and, as a number of checks have been obtained by means of water transfers on the Great Lakes and by connections at several points with the levels of the United States Coast and Geodetic Survey, it seems reasonable to assume that there will not be any very large change.

An article by the writer in *The Canadian Engineer* of April 20th and 27th, 1916, described in detail the territory covered, the datum planes used, and the methods employed by the Geodetic Survey in the extension of precise levelling. The fact was brought out that the levelling had been based upon three intermediate points besides the two coastal stations—Halifax and Vancouver—two of these points having been determined by the United States Survey. Publications have been issued by us each year for several years past giving the direct instrumental elevations along the lines in all five districts. It may be noted that the greatest difference at any bench-mark between the published elevation and the new "short-line" elevation is no greater than the above-mentioned closing error of 1.17 feet.

A word as to the route followed by this line, which, with the exception of two or three short jumps across country, lies along the railways for its whole distance. Starting at Halifax, the route of the Dominion Atlantic Railway is followed to Truro, thence the Canadian Government railways through Moncton and Edmundston,



Last Sight Being Taken at Port Arthur, October 17th, 1916.

N.G., and to a point about 95 miles west. From here we go across country to St. Philippe-de-Neri, Que., on the Intercolonial, and follow this and the Grand Trunk through Levis and Richmond to St. Hyacinthe. A combination of C.P.R. and G.T.R. lines then carries us along—south of Montreal and Ottawa—through Farnham, St. Johns, Lacolle and Coteau, Que., and Smith's Falls, Ont., till we reach Arnprior. The route is then by G.T.R. to Parry Sound, Ont., C.P.R. to Sault Ste. Marie and Algoma Central Railway to Franz—the junction with the C.P.R. main line. The latter is then followed to Port Arthur and the C.N.R. to Emerson, Man. From this point we go across country a few miles to Gretna, Man., and then follow the C.P.R. to Kamloops, B.C., the line chosen passing through Estevan, Moose Jaw, Lethbridge and Calgary. From Kamloops the C.N.R. is followed to within a short distance of Vancouver and the balance of the line lies along the Great Northern Railway.

The length of the route selected is a little over 4,000 miles, all of which lies in Canada with the exception of about 44 miles, for which distance the C.N.R. between Port Arthur and Emerson passes through the State of Minnesota.

Publications giving precise elevations of bench-marks, etc., on many of the above and other lines are available for distribution for the asking.

The combined population of the municipalities now served by the Ontario-Hydro Electric Commission through the medium of its various systems is 1,137,795.

HOW CAN THE ENGINEER IMPROVE HIS PUBLIC STANDING?

By F. W. Hanna,
Consulting Engineer, United States Reclamation Service, Ankeny, Iowa.

THE engineer's standing (or lack of standing) in the public mind and in public affairs is due to (*a*) the nature of engineering work, (*b*) the public's method of valuing men, and (*c*) the character of the engineer's education. The first of these causes is not susceptible of such changes as will materially affect the engineer's public status, but the second and third are not so strictly limited.

The remoteness of the benefit to be derived from a piece of engineering work makes its importance indistinct to the public vision. The design of a bridge is so far removed from its use in traffic that the public seldom connects the engineer with commerce and human travel; the survey of a reservoir site is not vividly enough related to the growing of crops on an irrigation project or the use of water from a faucet in the house to make vivid in the mind of a public the usefulness of the engineer. Neither does the hazy concept of the part taken by the engineer in these enterprises permit the public to appreciate the amount of intelligence and labor devoted to the design and the survey.

These illustrations are typical of practically all engineering operations. The engineer is assumed to evolve railroads, power developments and irrigation projects as an ordinary, easy natural process. His unseen mathematical calculations pass with the public as rapid addition at best, and his field work is mere ability to run a compass. The insight is little deeper than the public's knowledge of its tangible experience. This phase of the nature of engineering work is worthy of consideration, however, as the engineer must cope with it, and he should do it understandingly.

The public method of human valuation is generally imperfect, because its conclusions are usually drawn from a partial knowledge of the facts. Its facilities, time and ability for securing complete premises for conclusions are limited. The public necessarily consists of a mixture of individuals with varying mental dimensions and varying education, all intensely employed in their own affairs. The public seldom searches deeply for facts, and it is impressed on the average only by obvious truth. This is why all reforms are so painfully slow in realization and is also why the services of the engineer to humanity are little understood and poorly appreciated. The engineer's only remedy for this trouble is to get the facts before the public so that they will be obvious to it, through the use of the press, the school, the rostrum and literature.

The school, the press, the public rostrum and literature are the main sources of public information outside of the experience in the daily routine of life. The public is ready to read entertaining newspaper accounts of engineering works, and the scenes of a play or the plot of a novel can well be centered about some great piece of engineering work. Few engineers can succeed in writing plays or novels; and were they to do so they would turn their talents in that direction, as did Robert Louis Stevenson and F. Hopkinson Smith. The engineer, however, may endeavor to interest writers intelligently in the human as well as the material side of his work, and he may also improve opportunities to lecture on engineering and related subjects with resulting benefit.

Faced by such a literary and oratorical program, the engineer will often shrink rightfully from objection to self-advertisement, but wrongfully from fear of commercialization of his profession. Moreover, he generally feels incompetent to carry out his part in such a program, from lack of college training along certain lines. This indicates where some changes in our college engineering courses would be helpful.

The engineer on leaving college is not well-balanced educationally. He is well equipped to grapple with the laws of nature, but not with those of human nature. He has been trained thoroughly, and rightly so, in all the natural, rational, pure and applied sciences, but generally he has only a smattering of English, supplemented with a like smattering of German or French or Spanish. He knows but little psychology, political economy and sociology, but little law, too little of anything, in fact, that gives him an insight into human affairs outside of his own profession.

The college courses are only partly to blame for this state of affairs. The engineering student almost always sees his chosen profession too narrowly and avoids and slights the broadening subjects in his course of study. He conceives his profession to be that of converting the raw materials and potent forces of nature into human use, without seeing the necessary intervening and important conversion of his fellow beings into supporters of his projects. After some years of experience he learns that the latter is one of the big factors in his profession and then wishes that he could understand human nature and speak and write better.

The study of French or German or Spanish has a fine theoretical basis for its future utility in the engineering profession. A few of our engineers read engineering literature directly in these foreign languages, but most of us soon forget how to read them and depend on translations for our foreign information. A few of our engineers go into foreign lands and use directly the foreign languages learned in college, but the great mass of them find employment in their own country. Consequently, the large majority of engineers receive practically no other benefit from the study of foreign languages than that of general culture.

On the other hand, this large majority would receive the same mental culture and also an immense practical benefit through the substitution of a more thorough study of the English language and its literature. Let the engineer have enough rhetoric to make his tongue and pen certain of their ground, enough debating and oratorical work to induce a natural flow of speech while standing before an audience, and enough literature to loosen his poetical imagination and awaken his interest in the higher relations of mankind. He will then be better fitted to take his proper place in public affairs.

An intimate acquaintance in college with the fundamental laws of the human mind and with those of human society would be of profound service to the engineer in his dealings with the public. An understanding of these laws is just as essential to successful dealings with the public as is an understanding of the laws of inanimate nature and mathematics to the efficient handling of the material problems of engineering.

Due to his college training in mathematics, physics, mechanics, chemistry and the like, the young engineer readily and quickly manages problems involving their use. Occasionally an engineer has acquired an understanding of these fundamentals in his busy life of practice, but he was handicapped for their lack during several of the most useful years of his life. The engineer graduate now suffers a similar handicap in his knowledge of the human mind, human society, human institutions. He is compelled to buffet against the world for a long time before he is equipped to handle a position involving serious dealings with the public. While more liberal college training in psychology, sociology, and political economy would not eliminate all of this buffeting, it would greatly lessen the length and severity of the apprenticeship.

The engineer's analytic habit of mind, his accuracy of thought and his honesty of purpose are excellent qualities for men in public service; but greater endeavor on the part of the engineer to secure public appreciation and better preparation of engineer graduates in their college work for public service will aid greatly in enlarging the engineer's share of appointments and elections to positions of public authority and influence.

GENERAL PAVING PRINCIPLES.

At the January meeting of the American Society of Civil Engineers, the "Committee on Materials for Road Construction and on Standards for Their Test and Use" presented a progress report, which consisted chiefly of a statement of the fundamental principles on which specifications covering each of the several types of roads and pavements should be based. As a preliminary to the discussion of the several types, it presented certain general principles which, although more or less elementary and fundamental, are often found to be neglected by those engaged in roadway work. These we have somewhat condensed in the following:—

Lines and Grades.—Choice of the material, or methods of using a particular material, may be affected by the grades as fixed. Certain materials, or results of using materials, for highway surfacings will be unsatisfactory outside of certain limits of grades. Conservative practice has fixed the maximum limits for satisfactory results with grades, as follows:—

Kind of Roadway.	Maximum Grade Per Cent.
Gravel	12.0
Broken stone	12.0
Bituminous surface	6.0
Bituminous macadam	8.0
Bituminous concrete	8.0
Sheet-asphalt	5.0
Cement-concrete	8.0
Brick (cement grout filler)	6.0
Brick (bituminous filler)	12.0
Stone block (cement grout filler)	9.0
Stone block (bituminous filler)	15.0
Wood block	4.0

Width.—Where motor traffic forms a considerable proportion of the total traffic likely to use a highway, the unit width of traffic lines to be considered is 9 or 10 ft. instead of 7 or 8 ft. as heretofore, because of the greater clearance required for the safe passing of the units of such traffic.

Where bituminous pavements are laid, the edges need protection and a sudden transition from the pavement to any softer shoulder material should be avoided by means of extra width, or of cement-concrete or other edges, and such reinforcement of the shoulder material as may be necessary.

The width of roadways of rigid material, such as cement-concrete or vitrified block, should be at least equal to what would be prescribed under local conditions for a less rigid surfacing. The great difference between the firmness of a rigid roadway surfacing and of material frequently available for the shoulders thereto, often makes it necessary, for safety and convenience of traffic, as well as for economy of maintenance, that the rigid surfacing should be built wider than would answer for a more flexible surfacing, such as water-bound macadam, for instance, under the same local conditions.

Too narrow a width of roadway encourages, if it does not compel, concentration of traffic to such an extent as to make frequently unfair demands on what would otherwise be a suitable and efficient material for the surfacing. This may be especially noticeable at abrupt changes in the lines of the highway, where any tendency toward the improper concentration of traffic into too narrow areas should be avoided, as far as possible, by such adjustment or separation of lines, and adjustment of width, of crown, or of slope of the roadway surfacing, as will keep the strains of the surfacing material within reasonable limits for it.

Thickness.—The thickness of the pavement or surfacing, of course, will be dependent largely on its type, but it will also be affected by the presence or absence in the construction of an artificial foundation, and, in fact, on the character and ability of the base on which the surfacing is to rest. Approved practice establishes the limits given in Table I. for the extremes of thickness for the various layers of the pavement or road crust.

Table I.

Kind of roadway.	Thickness of artificial foundation,* in inches.	Thickness of sand cushion or binder course, in inches.	Thickness of wearing course, in inches.
Gravel	4 to 8	....	2 to 4
Broken stone	3 to 8	....	2 to 3
Bituminous surface	4 to 8	....	¼ to ½
Bituminous macadam	3 to 8	....	2 to 3
Bituminous concrete	3 to 8	....	1½ to 3
Sheet-asphalt	5 to 8	1 to 1½	1½ to 2
Cement concrete (one-course)	......	....	5 to 8
Cement concrete (two-course)	4 to 8	....	2
Brick	4 to 8	¾ to 1½	3 to 4
Stone block	5 to 12	1 to 2	2½ to 5
Wood block	5 to 8	½	3½ to 4

*Not including extraordinary provisions such as V-drains or sub-base courses.

Although the general practice has been too often perhaps to use mass, for the sake of safety, in the preparation of the pavement, it now appears to be evident that some waste has been incurred in the past in this direction, and that a more scientific determination of the thickness, as well as of many other features of highway work, is possible, without sacrifice of safety and yet with economy. However, in view of the recent, constant, and rapid increase of the weight of, and consequently of the strains caused by, the traffic, it will be in the interests of economy for designs of highways to be made with proper consideration of further increases.

Drainage.—The use of any form of pavement or road crust, whether bituminous or non-bituminous, does not relieve the necessity of proper drainage in every case. It is not only necessary to provide for such under-drainage as will place and keep the sub-grade in a condition satisfactorily free from moisture and in a state of suitable efficiency, but it is also necessary to provide and to preserve economically such provisions for surface drainage as will, with the provisions of under-drainage, insure these results fairly permanently. Storm-water coming to the roadway must be carried quickly and rapidly away from it by automatic arrangements to the natural water-courses, where it can be disposed of finally. The arrangements referred to and so made, such as inlets, ditches, gutters, and culverts, should be designed and placed so as to give the least possible offence to the users of the roadway and the abuttors, and yet be built so as to preserve their integrity and efficiency with the least need for attention and expense under even the most persistently adverse natural conditions. A proper longitudinal grade for ditches and gutters is particularly important, in order that the ill and wide effects of standing water may be avoided. A proper cross-section for ditches is also important, in order that the waterway may not become obstructed by the sliding in of the sides.

As related to drainage, the matter of the crown of the roadway is particularly important. The ideal roadway surface would be flat in cross-section were it not for the necessity of the automatic removal of surface water to the channels where it must be most conveniently carried along. Crowning the roadway tends to concentrate the traffic on the ridge where it is then most comfortable for the travellers, and the amount of crown which will result in this concentration on the ridge varies with the type of pavements. Also, the rate of crown necessary for the proper removal of storm-water to the gutters or ditches varies with the type, and with the provisions to be made for the cleaning and the upkeep of the roadway surface. In the general practice, the amount of crown for the shoulders of an uncurbed roadway has usually been a cross-slope of one inch per foot, the shoulders being of the natural earthy material, and this rate is to be recommended for shoulders, except in special cases.

The crown generally used in the construction of broken stone roadways is excessive when bituminous materials are used, and a crown of even one-half inch per foot should be avoided when a lesser crown can be secured without detriment to the surface drainage.

For the various roadway surfacings, the practice generally observed and to be recommended is as given in Table II.

Table II.

Kind of roadway.	——Crown Recommended—— Maximum.	Minimum.
Gravel	1 in. to the ft.	½ in. to the ft.
Broken stone	¾ " " " "	½ " " " "
Bituminous surface ...	½ " " " "	¼ " " " "
Bituminous macadam .	½ " " " "	¼ " " " "
Bituminous concrete ..	½ " " " "	¼ " " " "
Sheet-asphalt	¼ " " " "	⅛ " " " "
Cement-concrete	⅜ " " " "	¼ " " " "
Brick	⅜ " " " "	⅛ " " " "
Stone block	½ " " " "	¼ " " " "
Wood block	¼ " " " "	⅛ " " " "

Concave pavements of cement-concrete, vitrified block, or stone block may frequently be found advantageous for alleys, and, in such cases, the same rates of slopes in cross-section as those previously given should govern.

Artificial Foundations.—Where the character of the traffic justifies the use of an artificial surfacing, it also demands a correspondingly strong foundation. Whether or not an artificial foundation shall be supplied will depend on the local conditions, but in the selection of the materials and the methods of construction of the artificial foundation, every consideration should first be given to the possibilities for securing the greatest efficiency from the natural foundation. Economy in reference to the roadway will be had from the proper choice of the various materials available for artificial foundations, such as sand, gravel, broken stone, and concrete.

In the construction of a concrete foundation, the subgrade should first be properly prepared and its greatest efficiency developed. The thickness of the cement-concrete artificial foundation usually laid is 5 or 6 inches, but it may be varied advantageously according to the local conditions between 4 and 12 inches. The thickness may be varied sometimes between the centre of the roadway and the sides.

The most usual proportions for a cement-concrete foundation have been one part cement, three parts fine aggregate, and six parts coarse aggregate. This standard, however, is empirical rather than scientific, and a more rational proportion in any case should be developed according to the needs and facilities of each case. It may often be desirable to increase the mass in some cases at the expense of unit strength, or to increase the mass for the sake of economy in the more expensive material.

Subgrade.—The use of any form of pavement or road crust does not relieve the necessity for the construction of a well-drained, thoroughly compacted, homogeneous, and stable subgrade in every case. Indeed, such improvement of the highway generally attracts heavier traffic and thus increases the stresses on the subgrade. Even when an artificial foundation is to be constructed on the subgrade, proper attention should be given to the preparation of the latter, in order that the greatest economy may be had in the design and expense for the artificial foundation, and, generally speaking at least, the higher the type and the more expensive the artificial foundation, the greater care should be exercised to develop to the utmost the possibilities of the subgrade. Uniformity in its composition and compaction, as well as evenness of its surface, is far more important than has apparently been generally considered necessary up to this time, and permanence of all the desirable qualities in the subgrade is equally important.

Joints.—For the ordinary joints in block pavements, the materials and methods of filling should be selected so as to produce not only a surface which will retain to the utmost its imperviousness and the stability of the blocks themselves in place, but also as far as practicable they should conduce toward evenness of wear of the surface of the pavement. If the blocks are resistant to abrasion, but perhaps inclined to round off at the edges of the upper surface under traffic, such filling of the joints is desirable as will lend additional resistance in the blocks to this rounding off at the joints.

A bituminous filler may be preferred to a cement-grout filler, on account of the lower cost of street-opening repairs, the better foothold provided for horses, and the securing of a more resilient and hence less noisy pavement. On steep grades, where some roughness of surface may be desirable for the sake of affording better foothold for animals, some openness at the top of the joint is desirable, and the bituminous joint fillers may be preferred. With bituminous joint fillers, care must be taken to select materials which will not be too brittle in cold weather and so chip out from joints under traffic, and which will not be so soft in hot weather as to flow out of the joints between the blocks. It is believed, although not yet generally admitted as having been actually proven by experience, that the use of a bituminous mastic for joint filling would be an improvement over the customary practice of using bituminous material alone for this purpose. Great care should be taken with bituminous fillers of any kind to insure the actual filling of the joints between the blocks, and great care must be taken to insure this result.

Shoulders and Gutters.—Where rigid or fairly rigid pavements are laid, their edges should be protected and the sudden transition from such a pavement to any softer shoulder material avoided by means of edges or such reinforcement of the shoulder material as may be necessary. The line or strip of contact between a cement-concrete roadway and the flanking material of the shoulders being the zone of weakness under traffic, it is important to accommodate the traffic and to protect the roadway as well as the shoulders from the formation of ruts along this line. This is especially true when the roadway is so narrow as to result in the frequent passage of vehicles from the pavement to the shoulders.

Such material for and construction of the shoulders should be had as will result in their being capable of efficient and economical maintenance under the local conditions existing or likely to prevail.

The shoulders may be reinforced with paving, concrete, macadam, gravel, or similar surfacings; or they may be of the natural local material available, due consideration being given to the advisability of tapering down from a relatively high rigidity of the roadway itself to any soft natural material at the outside edges of the road.

Finishing of Surface.—An objectionable slipperiness of many pavements may be decreased or prevented by proper precautions during construction or by proper treatment thereafter. The length of time that a finished pavement should be closed to traffic in order to season properly before use varies from a few hours to several days, dependent on the character of the material and methods used and on climatic and other local conditions. Pavements in which Portland cement is used for filling the joints or in the mass of the surfacing itself should seldom, if ever, be closed for less than two weeks after completion.

The committee consists of W. W. Crosby, chairman; H. K. Bishop, A. H. Blanchard, secretary; A. W. Dean, N. P. Lewis, C. J. Tilden and G. W. Tillson.

RAILROAD EARNINGS.

The following are the weekly earnings of Canada's transcontinental lines during March:—

Canadian Pacific Railway.

	1917.	1916.	Inc. or dec.
March 7	$2,442,000	$2,198,000	+ $244,000

Grand Trunk Railway.

March 7	$1,063,190	$ 992,026	+ $ 71,164

Canadian Northern Railway.

March 7	$ 669,100	$ 540,200	+ $128,900

PROPOSED EXTENSION OF WATERWORKS AND SEWERAGE SYSTEMS AT TRAIL, B.C.

HEREWITH is presented a summary of reports submitted to the corporation of the city of Trail, B.C., by A. L. McCulloch, consulting engineer, Nelson, B.C., for the proposed extension to the waterworks and for the proposed sewerage system.

Waterworks.—The present system was constructed by a private company in the early days of the city's growth. It was bought by the municipality in 1910, the supply being by gravity from a small mountain stream, supplemented by an additional supply through a 4-inch pipe from the smelter water supply, the latter being, however, only intended as an emergency supply.

On account, however, of the rapid growth of the city in the last two or three years, the present supply is not satisfactory, even for domestic supply, and is totally inadequate for efficient fire protection.

The present population of the city is estimated at 4,000. There has been an increase of 40 per cent. in the school population of the city during the last 12 months, and in all probability there will be a large increase in population during the next 12 months.

It is therefore essential that something should be done at once to secure an adequate water supply and to build larger mains for adequate fire protection.

Available Supplies.—To get the amount of water required with an assurance of a reasonable supply for the future growth of the city the following sources could be utilized:—

(1) By gravity from Cambridge Creek, supplemented by the storage and use of water from Violin Lake.

(2) By pumping water from the Columbia River.

(3) By a gravity supply from Blueberry Creek, distant 17 miles from the city. This supply, on account of the cost, could only be developed in conjunction with the Consolidated Mining and Smelting Co., who also need to supplement their present gravity supply.

All the other streams in the neighborhood of the city, including Rock, Stoney, Murphy and Trail Creeks, are utilized as a water supply to the smelter.

Of the three available supplies, that from Cambridge Creek is easily the best and cheapest to develop.

In December there was a flow in Cambridge Creek of 630,000 gallons per day, while the flow from Violin Lake was 260,000 gallons per day, a total of 890,000 gallons per day, with an estimated extreme low-water flow of 600,000 gallons.

By utilizing the storage possibilities of Violin Lake this available daily supply can be increased to over 1,500,000 gallons per day.

Violin Lake is at an elevation of 1,850 feet above the business portion of the city. It is a long, narrow lake, being about one mile long, and has a surface area of 50 acres; it has a depth of 60 feet, the depth at 25 feet out from the proposed point of diversion being 9 feet.

Between Violin Lake and Cambridge Creek there is a ridge or divide 23 feet above the level of the water in the lake, the distance being 2,650 feet to get to a point on Cambridge Creek at the level of the lake.

This divide presents obstacles to utilizing Violin Lake to supplement the flow from Cambridge Creek.

It is feasible to conduct the water over this ridge by a syphon, which, however, may require almost daily attention, and on account of the remoteness from the city (about 7 miles) should only be resorted to if a gravity flow conduit is impracticable, which it is not.

Mr. McCulloch is of the opinion that the most economical method of diverting this water is to raise the level of the lake permanently 10 feet and lay a 14-inch tile conduit through the ridge at a depth of 13 feet. It is proposed to construct an earth dam at the outlet of the lake to a height of 25 feet, with suitable sluiceway and spillway, and utilizing the lake for storage purposes between elevations 10 and 20 feet; the cost of the development at the lake to be $11,000.

From the diversion weir on Cambridge Creek the water will be conducted by a pipe line 8,400 feet long with a daily capacity of 1,500,000 to a 1,000,000-gallon distribution reservoir at the city limits, at an elevation of 375 feet above the business portion of the city. This elevation is necessary in order to give suitable pressure to the higher portions of the city, the pressure on the lower or business portion being reduced by the use of pressure regulator valves on the supply mains to any desired pressure.

Distribution System.—The new mains to consist of 1,950 feet of 10-inch pipe, 6,420 feet of 8-inch pipe, and 9,000 feet of 6-inch pipe. There will be 14 new hydrants, 28 new gate valves and 2 pressure regulator valves.

In the new system under ordinary conditions the engineer favors the use of steel pipe throughout, but on account of the present abnormally high price of steel pipe (the present factory prices being 75 per cent. higher than in January, 1914, 87 per cent. higher than in 1915, and 70 per cent. higher than in January, 1916) puts a somewhat different complexion on the matter and it is felt that the merits of steel and wood pipe would have to be considered under present conditions.

It is almost impossible to get deliveries from the shops, within any reasonable limit, and the steel pipe that is used will have to be purchased from the stock held by dealers.

Wood-stave pipe is favored for the conduit pipe line from Cambridge Creek to the reservoir. This is also true of the 10-inch main from the reservoir, and in the 8-inch supply main along the bench to the corner of Spokane and Green Streets, a distance of 4,450 feet, being approximately 200 feet above the business or main portion of the town.

The estimated cost of the proposed waterworks system is $60,000.

Sewerage System.—On account of the ease with which surface water can be handled, due to the topography and the natural drainage into the Columbia River and Trail and Gorge Creeks, which run through the city, it is not proposed now to provide for surface water in the sewers to be constructed.

A modification of the separate system of sewers is recommended,—one that takes care of all sewage proper and provides for the roof water as well.

It is proposed to empty the sewage into the Columbia River, which at Trail has an extreme low-water flow of 14,000 cubic feet per second.

On account of the scarcity of labor and the consequent high wages, the recommendation is made that the whole of the pipe be laid in one contract, so as to make it worth while for a contractor to come in with a suitable plant, the material to be excavated being very suitable for trench excavating machines.

It is proposed to construct 22,100 feet of sewers. The main sewer, being 15-inch and 12-inch, will be 1,650 feet long, while the laterals, amounting to 20,450 feet, will be 8-inch and 6-inch, the latter on steep grades on short branch sewers.

The probable cost of the proposed system will be $40,000.

A by-law is to be submitted to the ratepayers as soon as the proposed source of supply is approved by the Provincial Board of Health.

ADDITION TO STANDARD UNDERGROUND CABLE PLANT AT HAMILTON.

In preparation for the prosperous times which the company anticipates will prevail after the close of the war, the Standard Underground Cable Company of Canada, Limited, is making an addition to its factory at Hamilton, Ont., which, when completed and equipped with the necessary machinery, will represent an investment of $50,000. The new structure will consist of one story, with basement built of brick and concrete, and will be 125 by 120 feet, giving a total increase in floor space of 30,000 square feet. Ample fire protection apparatus is also provided for, which includes a complete automatic sprinkler system.

The new building will be devoted exclusively to the uses of the wire-drawing department, and in addition to housing the former equipment will contain material additions of new machinery of the latest design capable of drawing wires ranging in size from No. 40, B. & S. C., which is about the thickness of a hair, to the largest size of trolley wire; also machines for grooving trolley wire and for rolling flats and squares, such as are used in the manufacture of magnet wire. There will also be two new "Bright-annealing" furnaces for annealing or softening the wire after it has been drawn. This addition will not only give room for a considerable increase in the output of the wire-drawing department, but the space released will allow for expansions in the stranding and cabling departments.

All of the machinery in the new plant will be electrically operated by three-phase alternating current motors of 550 volts, 25 cycles, the current being furnished by the Hamilton Hydro-Electric Department and carried from the overhead transmission lines of the department to the transformers on the company's property by underground cables. Power is now taken for other uses in the plant from the Dominion Power and Transmission Company. The architects are Prack and Perrine, of Hamilton.

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended March 9th, 1917:—

Trethewey Silver Mines, 37,297; Hudson Bay Mine, 65,382; Kerr Lake Mining Company, 86,619; Coniagas Mine, 78,689; La Rose Mine, 87,424; Dominion Reduction Company, 149,000. Total, 504,411 pounds, or 252.2 tons.

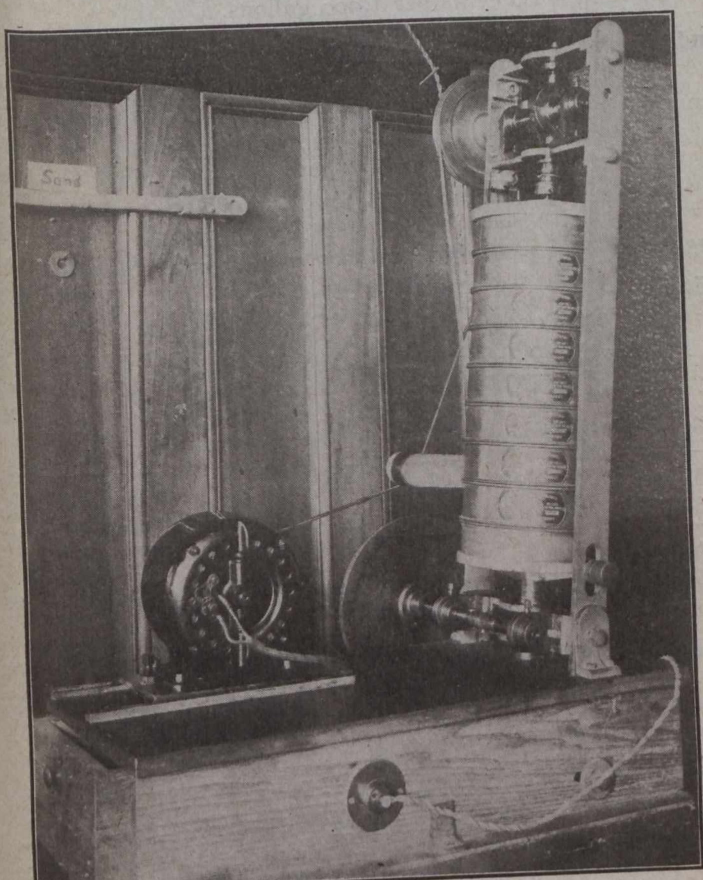
The total shipments since January 1st, 1917, now amount to 4,289,973 pounds, or 2,144.9 tons.

An illustrated address was given on March 14th, at the Shaughnessy Building, by Mr. George M. Berry, chief chemist of the Holcomb Steel Company, of Syracuse, N.Y., and inventor of the process by which hydro-electric power has been commercially applied to metallurgy. The lecture was arranged by Arthur D. Little, Limited, under the auspices of the Canadian Pacific Railway, with a view to showing what could be done to use undeveloped water powers in Canada to develop other industries, and especially the electrical making of high grade steel.

A NEW SAND SIEVING MACHINE.

THE accompanying illustration is of a recently developed sieving machine that is a part of the equipment in the Montreal paving laboratory of the Milton Hersey Company, where it is used for making the screen analyses of sands for asphalt pavement, concrete work and other similar tests. There are but two other machines like it, the original model at McGill University and one other that was specially built for a large mining and smelting company.

This machine is so constructed that it may be readily and accurately adjusted to the requirements of different classes of material. The inclination of the sieves may be set to suit the work in hand, the weight of the tap or blow may be governed, and the speed of the revolutions and number of blows may be changed by using different sized pulleys or a motor with different speed.



Bell Sand Sieving Machine.

The standard adjustment, however, is the result of much very careful experimenting on the part of Professor Bell, who sought and found the combination of movements that would with the least wear and tear and in the shortest period of time furnish results that would be sufficiently uniform for scientific purposes.

In operation the nest of sieves is forced down by a cam on the horizontal shaft above against a spring in the base of the machine. When the cam releases the sieves they are forced upward by the spring through a distance of about one-tenth of an inch, and in being brought to a sudden stop the grains of material on the sieve cloths are thrown upward in a manner tending to clear the apertures. The force of the spring-blow may be adjusted as desired, but an eighteen-pound pressure has been found to be satisfactory. The distance of the upward throw of the sieves can be also adjusted.

A satisfactory adjustment for general purposes was found to be four hundred taps per minute while the sieves were revolving at the rate of two and one-half full turns per minute. The rate of rotation of the sieves in conjunction with their inclination distributes the material over the screen cloths by causing the grains to reach the highest point and then slide down again. They journey in a more or less elliptical path. The best inclination for each class of material would slightly vary, as for coarse sand and hydraulic cement, for instance, but for practical purposes a satisfactory compromise is easily determined.

So far, no move has been made to manufacture this machine on a commercial basis. It was developed for use in connection with some very important investigations in which it was found that other machines did not give sufficiently accurate results. It is the invention of Mr. John W. Bell, M.Sc., assistant professor of mining engineering at McGill University, Montreal.

WATER SUPPLY OF MOOSE JAW, SASK.

Mr. Geo. D. Mackie, city commissioner of Moose Jaw, Sask., has recently issued a report dealing with the water supply of that city, from which the following abstract has been taken:—

In any waterworks, whether public or private, the yearly expenses which have to be provided for may be included under the following heads:

1. Interest on bonded debt.
2. Yearly payment into sinking fund.
3. Yearly payment into depreciation fund.
4. Yearly operating and maintenance expenses.

All of these payments, if the waterworks plant is to be run on a proper basis, must be met fully year by year out of the annual income.

The functions performed by a waterworks plant are:

1. To furnish water for private use.
2. To furnish water for public use, such as street sprinkling, sewer flushing, supply to public buildings, etc.
3. To furnish fire protection to property.

The sources of revenue of a waterworks department are derived from: 1st, the water rates, and 2nd, the funds received by general taxation. The former are paid by those who use the water, and the latter by assessment. The cost of furnishing water to private consumers should be paid by water rates on the basis of the quantity of water used. The cost of supplying water for public purposes should be paid by taxation according to the amount of water used, and the cost of fire protection should also be met by taxation, since the individual is benefited by reason of the protection afforded to property. As all water mains are generally laid of a size larger than is required for present purposes, the cost of providing for the future should also be met by taxation on the city as a whole.

From observations which have been made by waterworks engineers all over the continent, it has been found that from 30 to 50 per cent. of the total expense plus the cost of water used for public purposes, should be met by general taxation, and the remainder of the revenue obtained from the water sold.

In arriving at the rate which should be charged the property owner whose land abuts on a water main, the rate should be equitable in regard to the benefit which accrues to the property so situated. The city imposes a frontage tax of from six to seven cents per foot for sewers, and a rate of ten cents per foot, in my opinion, would be equitable in the case of water mains. The frontage assessment for water in a number of cities is as under:

Regina	7	cents per lin. ft. of frontage per annum
Winnipeg ..	4	" " " "
Edmonton ..	10	" " " "
Calgary	10	" " " " (on unimproved property)
Calgary	5	" " " " (on improved property)

There is a doubt whether a frontage tax can be levied on property where mains have already been laid, but it has been done in the case of Regina.

The minimum charge for water in Moose Jaw for domestic purposes at present is $1.50 per quarter by way of a fixed charge, and $1.50 per quarter for water, making a total minimum charge per quarter of $3, or $12 per annum. If it were decided to raise the charge for water for domestic purposes so as to increase the revenue by fully $31,000 on the present basis of consumption, and leave the fixed charges as at present, the minimum rates would be:

Fixed charge per quarter	$1.50
Minimum charge for water per quarter	$3.00

or a total of $4.50 per quarter, or $18 per annum. The effect of this charge would be that the price of water for domestic purposes would be raised from 40 cents per 1,000 gallons to 80 cents per 1,000 gallons, and from a statement which I have already supplied you with, showing a comparison of the rates charged by different waterworks in the three prairie provinces, this new rate would make the rate charged by the city of Moose Jaw the most expensive of any of the waterworks in the provinces, with the exception of the town of Yorkton, where the rate charged is 80 cents per 1,000 gallons.

Statement of Waterworks Revenue and Expenditure for Various Cities for the Year 1915.

	Moose Jaw.		Regina.		Saskatoon.		Winnipeg.	
— Revenue —								
Commercial	$51,435.36		$137,733.36		$66,854.69		$486,704.93	
Departmental	3,889.90				6,662.90		24,994.57	
Fire department	10,623.33				14,000.00		69,060.00	
Miscellaneous							3,850.28	
		$ 65,948.59		$137,733.36		$87,517.59		$584,609.78
— Expenditure —								
Operating	$45,699.62		$ 49,822.88		$54,025.31		$234,322.57	
Sinking fund	20,485.51				8,961.52		102,097.00	
Interest	64,203.85		103,841.62		15,279.93		273,865.58	
Miscellaneous							760.81	
		130,388.98		153,664.50		78,266.76		611,045.96
Deficit		$64,440.39		$15,931.14				$26,436.17
Frontage taxes				27,652.04		(?)		73,730.16
Surplus				$11,720,90		*$9,250.83		$47,293.98

*The balance of interest and sinking fund payments on the capital expenditure of the waterworks, which is $1,132,424.51, is met by frontage assessment, the amount of which is not known.

	Moose Jaw.	Regina.	Saskatoon.	Winnipeg.
Population	16,889	26,105	21,054	163,000
Cost of plant	$ 817,000	$ 650,000	$ 281,574	$4,121,191
Cost of distribution system	536,000	670,000	1,003,342	2,205,777
Total cost of plant	$1,353,000	$1,320,000	$1,284,916	$6,326,968
Cost per capita	$80.11	$50.56	$61.02	$38.81
Number of services	2,000	4,039	2,284	32,108
Average daily consumption (in gallons)	718,492	2,193,026	1,140,827	8,000,000
Daily consumption per service	359.24	542.96	499.48	249.15
Daily consumption per capita	42.54	84.00	54.18	49.07
Revenue (commercial and departmental)	$55,325.26	$116,233.36	$73,517.59	$511,699.50
Revenue per 1,000 gallons	.21c.	.14c.	.17c.	.17c.
Revenue per service	$27.66	$28.77	$32.18	$15.93
Revenue per capita	$3.27	$4.45	$3.48	$3.13
Expenditure	$130,388.98	$153,664.50	*$78,266.76	$611,045.96
Expenditure per 1,000 gallons	.49c.	.19c.	*.18c.	.20c.
Expenditure per service	$65.19	$38.04	*$34.26	$19.03
Expenditure per capita	$7.72	$5.88	*$3.71	$3.74
Number of hydrants	303	430	452	2,072
Charge per hydrant	$35	$50	$30	$33
Mileage of water mains	68	55	44	250
Lineal feet water main per service	179.5	71.9	101.7	42.75
Lineal feet water main per capita	21.24	11.1	11.0	8.4

*The total expenditure in the case of Saskatoon cannot be shown as the amount levied for interest and sinking fund payments by way of frontage tax is not given separately in Saskatoon's financial statement.

NOTE—The figures in these tables are from the 1915 financial statements of the respective cities, or from the publication "Waterworks and Sewerage Systems of Canada," by the Commission of Conservation, Canada.

Editorial

THE ENGINEER AND HIS PUBLIC STANDING.

Much has been said recently as to the place of the engineer in the community, and rightly so. It seems to be very difficult for the general public to recognize the importance which attaches to the work of the engineer. Yet if the hand and brain of the engineer were to be taken away only for a week, virtually all the activities of the modern world would be paralyzed. But few seemingly give the matter a passing thought. The foundry, machine shop, draughting room, etc., and the equipment and mentality with which they work, are the underpinning and keystone of the present era.

Sanitation is bound up with public health, transportation with the question of food; water supply, printing, practically every service making for efficiency and convenience, together with every article of use, owes its present state to the work of the engineer.

In view of this, is it not entirely justifiable and, in fact, only proper that the engineer should assert himself as a factor in the community? It is safe to state without qualification that to the engineering section of the community the remainder of the people are in everlasting debt.

To the engineer himself who possesses imagination, a liner on her passage, an express train at full speed, a bridge spanning hundreds of feet, inspire a reverent feeling. While aware that they are common enough features, he realizes their magnitude and all the effort needed for their design and operation. The public, on the other hand, does not concern itself much with these things. Its valuation is superficial.

Only in the measure that the engineer asserts himself by means of the newspaper press, the school, the platform and literature, as is so clearly brought out in an article by F. W. Hanna on page 256 in this issue, will the engineer ever occupy his rightful place.

It is safe to assert that the administrative capacity in his possession is so general that his hand might safely guide and control in a more general sense.

The first step, however, is recognition. The community at large must understand that though generally silent, he is able and experienced in complex problems affecting quantities of men no less than in those dealing with quantities of materials. He may not be able to split hairs, not being trained in legal casuistry, but where practical administration is concerned, he should continue to find wider and greater opportunities than ever.

ORGANIZATION FOR HIGHWAY WORK.

While organization for the carrying on of highway work is only a means to an end, yet without proper organization neither construction nor maintenance can be carried on with the maximum of efficiency and economy.

The organizing of their forces is one of the real problems of those who are responsible for the construction and maintenance of roads. While there may be individual members of the working force who possess unusual skill, the results are bound to fall short of the ideal unless these various skilled units are welded together and made to do efficient team work through the assistance of organization.

Different conditions call for different forms of organization and no hard and fast rules can very well be laid down which will fit into all situations. There are, however, certain well-defined principles which are applicable in almost every case. Of these, perhaps the most important is that of delegating to each subordinate sufficient authority to enable him to produce the result for which he is personally held responsible.

Of course, it goes without saying that an organization cannot be efficient which does not have as the responsible head, an executive upon whom is imposed the task of securing certain definite results. Under him should be other executives upon whom are imposed certain duties along the line of general rules, but to handle the details without interference. Right here is where more otherwise model organizations have come to grief than through any other one cause, for men cannot and will not do their best work if there is any danger of interference.

If an organization is to continue and do its best work this principle of non-interference cannot be too carefully watched.

WORK OF JOINT COMMITTEE OF TECHNICAL SOCIETIES.

The Joint Committees of Technical Societies, embracing representatives of all the engineering societies in Canada, are meeting regularly in Toronto and in other centres.

The membership represented by these committees embraces about 10,000 engineers in Canada.

Each society is in touch with its members and each and every member is requested to send to their representatives suggestions of a practical nature that may tend to help the Canadian forces in the field or aid in solving the many problems now before us or likely to arise because of the war.

It is the one ambition of these technical men to serve. Many of them are too old to go to the front and many others, through the important positions they occupy, are doing better service here in Canada than they could perform in other spheres of usefulness.

While the Joint Committee is devoting a great deal of time to the work already allotted to them, they will be glad to take up any new work that appeals to them as within their scope, if any of the members will send them ideas along that line.

Inventions that will aid any branch of the service will be confidentially investigated and worked up by practical men, and if likely to be of service will, with the consent of the inventor, be forwarded to the proper authority for test and acceptance.

Suggestions for aiding recruiting for the engineering corps, employment of returned soldiers, research work connected with war materials or for processes of national importance will be taken up so far as facilities permit.

Correspondence on any of these subjects requiring technical advice or reports, should be sent direct to the secretary of the Joint Committee of Technical Organizations, Ontario Branch, Excelsior Life Building, Toronto, and will be acknowledged promptly.

The annual meeting will be held in the Chemistry and Mining Building, Toronto University, Toronto, the evening of March 30th, and will be addressed by Mr. John Murphy, chief electrical engineer of the Department of Railways and Canals; Mr. Matheson, late of Colorado but now chief engineer of the British American Nickel Corporation, and others. All engineers, whether members of any society or not, will be privileged to attend this meeting.

PRELIMINARY STATEMENT OF THE MINERAL PRODUCTION IN THE PROVINCE OF QUEBEC FOR 1916.

The first compilation of the mineral production of the province of Quebec during 1916 shows a total value of $13,070,566. As compared with the previous year, $11,465,873, this is an increase of $1,604,693, or 14%.

The mineral production is roughly divided into "products of the mine" and "building materials," and analysis of figures shows that the increase is wholly attributable to the former, which show an increase of 52.8%, whereas the building materials have decreased 18.5%. In 1915 the figures were: Produce of the mines, $5,223,639, or 46%; building materials, $6,242,234, or 54%. In 1916, produce of the mines, $7,982,430, or 61%; building materials, $5,088,136, or 39%.

This advance is very gratifying, especially when it is taken into consideration that the building materials, comprising limestone, granite, cement, lime, brick and other clay products represent a large proportion of the mineral production of the province.

The following table presents the total figures of the mineral production of the province for each year for the last 17 years:—

Year.	Value.	Year.	Value.
1900	$ 2,546,076	1909	$ 5,552,062
1901	2,997,731	1910	7,323,281
1902	2,985,463	1911	8,679,786
1903	2,772,762	1912	11,187,110
1904	3,023,568	1913	13,119,811
1905	3,750,300	1914	11,732,783
1906	5,019,932	1915	11,465,873
1907	5,391,368	1916	13,070,566
1908	5,458,998		

ANNUAL DINNER OF ENGINEERS' CLUB OF TORONTO.

The annual club dinner of the Engineers' Club of Toronto will be held Friday, March 23rd. The result of the balloting in connection with new club quarters will be announced. A musical programme has been provided and a large attendance of members is earnestly requested.

ENGINEERS' CLUB, PETERBOROUGH.

A well-attended dinner, given by the civil, mechanical and electrical engineers who are interested in forming an Engineers' Club, was held recently at the Oriental Hotel, Peterborough, Ont. The officers elected were: President, C. E. Canfield; secretary, G. R. Langley.

PERSONAL.

ARTHUR J. SMITH, building contractor, Brandon, Man., has enlisted for active service.

W. F. TYE, M.Can.Soc.C.E., of Montreal, has been engaged by the Hamilton city council to prepare a report on a common entrance for all railways into Hamilton.

A. E. FOREMAN, A.M.Can.Soc.C.E., formerly assistant city engineer of Victoria, B.C., has been appointed chief engineer of the department of public works of British Columbia.

ANSON J. HOPKINS, who has been with the Canadian Fairbanks-Morse Co., Limited, in Vancouver, was recently appointed general head of the accessory department of that company, and is now organizing the work of this department in the firm's eleven branches.

HENRY W. FISHER, chief electrical engineer, Standard Underground Cable Co., Perth Amboy, N.J., gave an illustrated address on March 16th before the Toronto Section of the American Institute of Electrical Engineers on "Underground Cables: Their Manufacture and Use Under Modern Practice."

R. O. WYNNE-ROBERTS, M.Can.Soc.C.E., Toronto, has become associated with Mr. Frank Barber in connection with the York Township water scheme and other works, and will conduct his practice as consulting engineer at 57 Adelaide Street East, Toronto, until the end of this month, when new premises will be taken.

OBITUARY.

GEORGE FOREST McKAY, of New Glasgow, N.S., who assisted in the founding of the Nova Scotia Steel & Coal Co., and who was the oldest director of the company, died on March 13th at the age of 82 years.

Lieutenant C. R. NEEDS, A.M.Can.Soc.C.E., civil engineer of the Canadian Aviation Corps, was killed in an aeroplane accident in England, February 27th. Lieut. Needs was resident engineer of the C.N.R. until the outbreak of war, when he went to Galt as chief inspector of the munitions plants there for the Canadian Inspection Co.

During the fiscal year ending June 30th, 1916, the city of Detroit laid 259,671 lin. ft., or 49.18 miles, of water mains.

The total expense for operating and maintenance of the water softening and purification works of the city of Columbus, O., for 1916 was $199,299, of which $24,902 was for labor and supervision, $168,346 for chemicals and $6,051 for general supplies. The cost of purification per 1,000,000 gal. delivered to consumers was $27.75.

According to a recent issue of a Buenos Aires paper, new steel works have been established at Santiago, utilizing the scrap iron which was previously exported to Europe. This new enterprise owes its existence to the high price of steel. Much difficulty was experienced at first in obtaining skilled workmen, but the situation was saved by the employment of Spaniards from Bilbao. It was necessary to set up a special plant for the manufacture of the machinery required, which is of European type. Chilean coal is used as fuel. The products of the new steel plant include merchant bars, sheets, angles, bars for reinforced concrete, nails, horseshoes, tires, etc. The price of Chilean steel is 20 per cent. less than that of the imported article. The quality may be considered as medium. The output of the new works is disposed of without any difficulty.