PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Proposed Filter Plant for Walkerville, Ont.

Details of New Plant to Be Erected Next Spring—Provision Made for Adding Units When Required—Initial Installation Calls for Maximum Capacity of 6.7 Million Gallons

IN view of the general industrial development that has characterized the Town of Walkerville, Ontario, during the past few years, and the prospects for still greater development in the days that are to come, it was inevitable that something would have to be done in order to meet and cope with the conditions so far as an adequate water supply is concerned.

In order to do this the Walkerville Water Co., Limited, has secured the services of Mr. R. Winthrop Pratt, of Cleveland, as Consulting Engineer, to design the new filter plant, and prepare plans and specifications for same.

The proposed lay-out of the plant will be clearly understood from the accompanying illustrations.

Location

The plant, Fig. 1, will be located on the north side of Sandwich Street, opposite the intersection of Walker Road. The main entrance to the head house is on Sandwich Street, the buildings extending from the street line to the present pumping station near the Detroit River. This location will necessitate the removal of one of the large tank warehouses belonging to the distillery of Messrs. Hiram Walker & Sons, Limited.

Basis of Design

The initial installation is designed to treat, normally, five million gallons per day, but provision has been made for increasing the capacity of the plant by the addition of an east wing similar in every way to the one shown west of the head house. Later, more filter units may be added to either end, increasing the capacity of the plant, first to ten, and then to fifteen million gallons. These additions will necessitate the removal of two or more warehouses now used for storing alcohol.

Owing to the intermittent demand at the Walkerville pumping station, it is estimated that a consumption of five million gallons per day will result in a rate, during certain hours, of from six to seven million gallons per day. It is therefore necessary to provide for such peak demand either by constructing ample storage for filtered

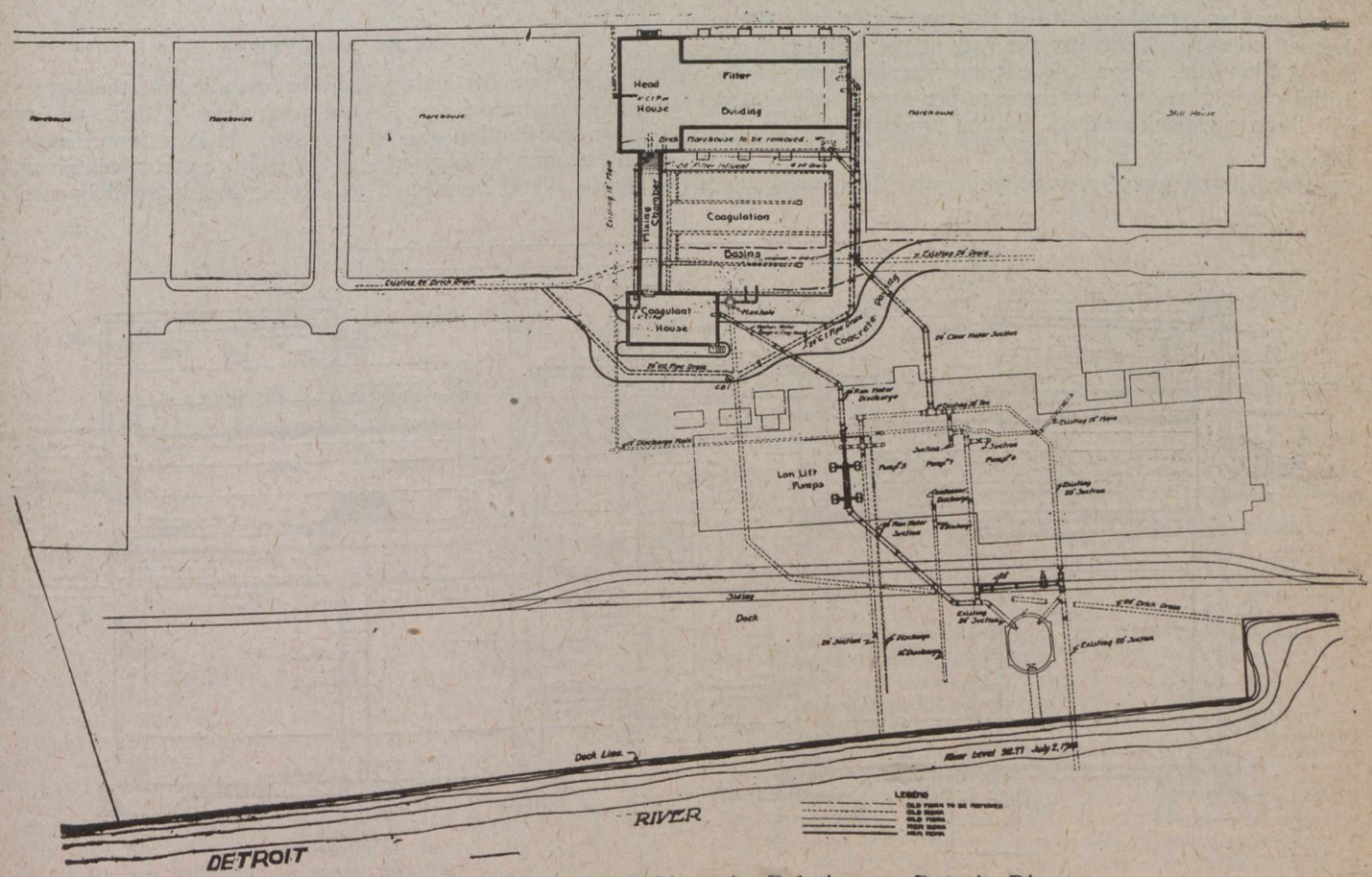


Fig. 1—Location of Proposed Plant in Relation to Detroit River

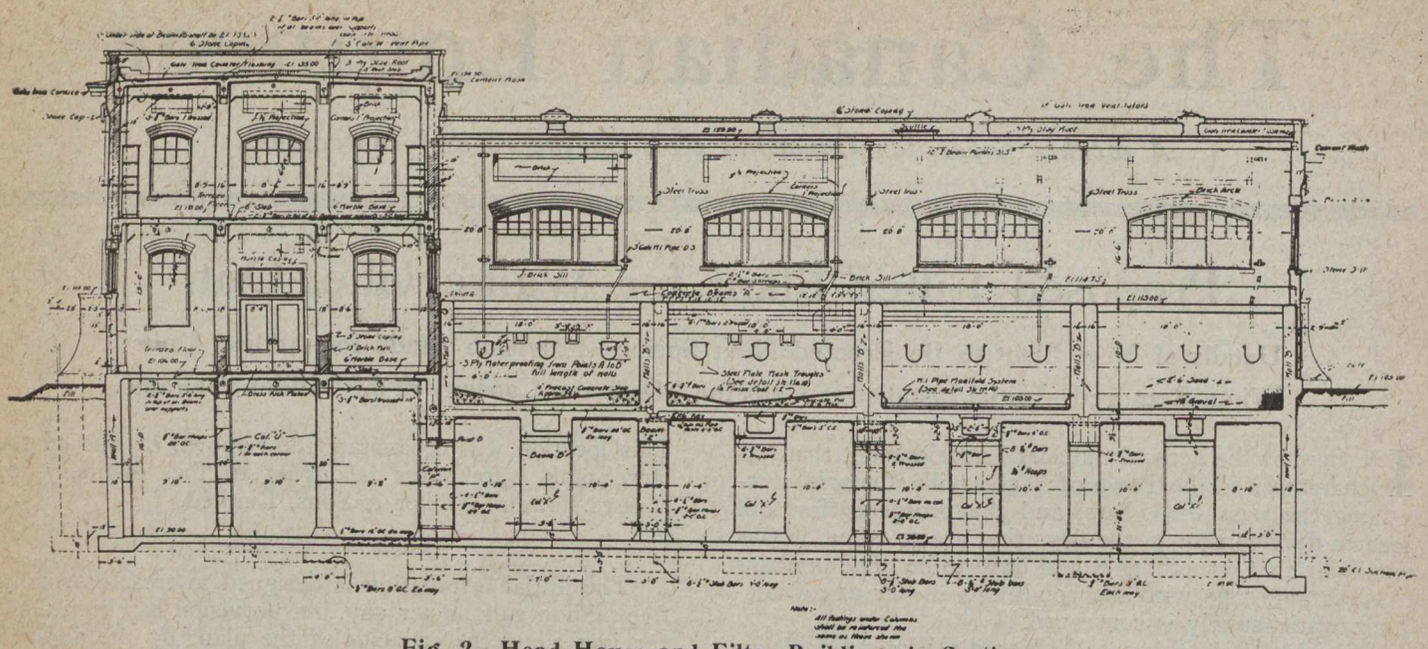


Fig. 2—Head House and Filter Buildings in Section

water or by providing additional filtering area. In view of local conditions and for economic reasons, the latter method has been adopted, i.e., of providing additional filter units.

The rate of filtration upon which the plan is based is 125 million Imperial gallons per acre per day. This rate, although somewhat higher than that ordinarily used with rapid sand filters, is nevertheless twenty-five per cent. lower than that which has been used with success at the Detroit City Test Filter Plant; but in order to provide for readily overcoming excessive turbidity or occasional biological growths in the raw water, it has been deemed conservative to use the rate above mentioned for the Walkerville design. The total filtering area in the initial plant, therefore, at the rate per acre above stated, will have a capacity of 6.7 million Imperial gallons per day.

The filtered water storage under the filters and head house will amount to 250,000 gallons; so that starting with a full basin, it will be possible to run for four hours at a rate in excess of eight million gallons per day without drawing out the water from beneath the filters, or without increasing the rate of filtration above that specified. It will be noted, therefore, that while the nominal capacity of the initial plant is five million gallons per day, it can be safely operated at a much greater rate.

Figure 2 shows the head house and filter building in section, while Figure 3 gives a sectional view of the filters on a larger scale.

Low Lift Pumps

The low lift pumps will be installed in the present pumping station, one having a capacity of three and the other five million gallons per day. If it is found impossible to get delivery of steam turbine pumps, centrifugal pumps direct connected to electric motors will be used.

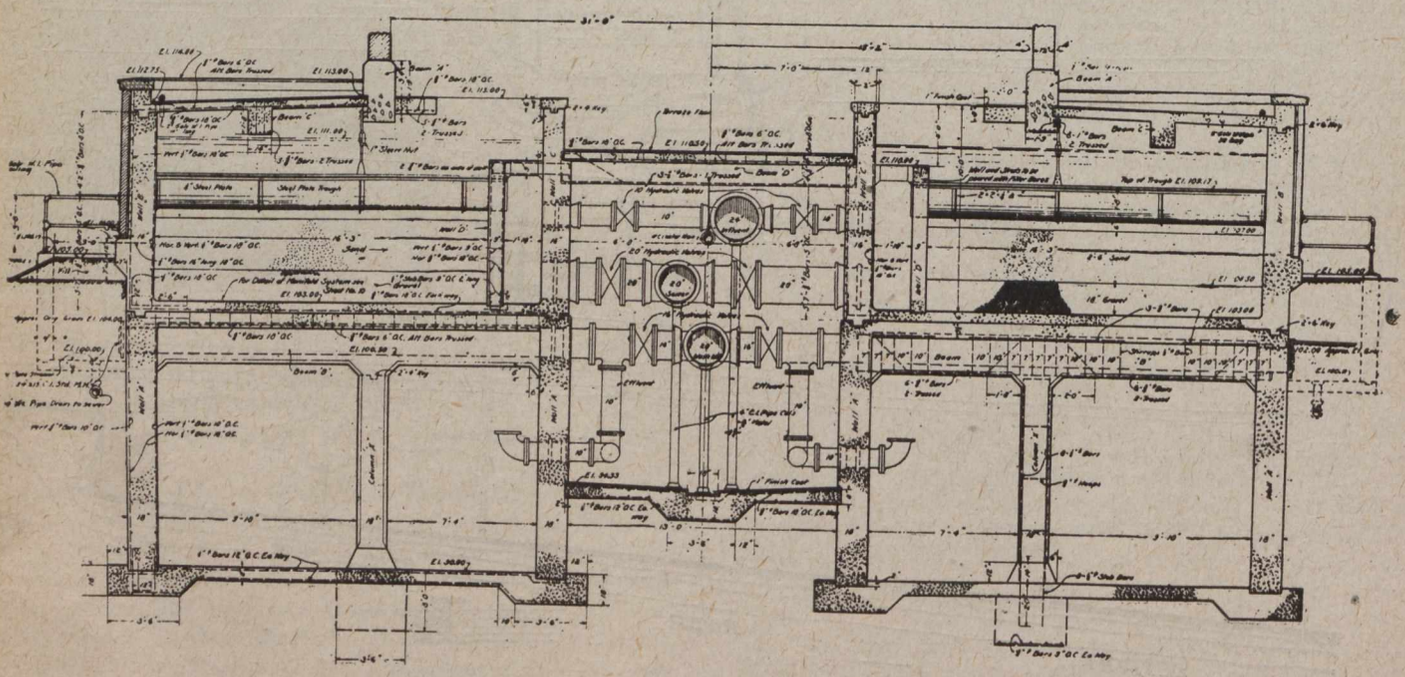


Fig. 3—Sectional View of Filters and Gallery

Mixing Chamber and Coagulation Basins

The low lift pumps will take the water from the present screen well and raise it into the mixing chamber at the upper end of which the coagulant solution will be introduced. The water is then carried through the mixing chamber at a high velocity by means of vertical baffles, so as to secure a thorough mixture between coagulant and water, for a period of five or ten minutes. After leaving the mixing chamber the water enters the coagulation basin, which is approximately 80 x 60 x 16, where it will remain for an average period of two hours, or a minimum period of one hour and thirty minutes.

Filters

From the coagulation basin the coagulated and settled water will pass to the filters, of which there are to be eight units, each 20 x 16 feet, placed on either side of the pipe gallery. The filters will be covered by that part of the building west of the head house as shown on the south elevation. The strainer system is simple, consisting of 3-inch wrought iron pipe perforated with two rows of ¼-inch holes, 4 inches on centres. Over these pipes is placed 18 inches of graded gravel and 2 feet 6 inches of sand.

Coagulant House

It is proposed to construct a building adjacent to the northerly end of the mixing chamber for the purpose of storing the coagulant as well as liquid chlorine, and for preparing the coagulant solution for application to the water. A covered passage is provided from the head house through the mixing chamber to the coagulant house.

Clear Well

As will be seen in Figure 2, the clear well extends under the head house and filter building. After passing through the filters the water is collected in this basin from where it is carried by gravity to the present pumping station through a 24-inch cast iron pipe.

Construction

Construction will in all probability be on the "cost plus" plan, but owing to the difficulty in procuring materials, actual building operations will not be undertaken before spring; however, it is proposed to contract for all material and equipment at once. The estimate of the cost of the building and fixtures is in the neighborhood of $200,000.

The Walkerville Water Co., Limited, of which Mr. C. D. Brown is Secretary-Treasurer, has been in operation since 1880, and is supplied by gravity from the Detroit River. This system also supplies Ford and Sandwich East.

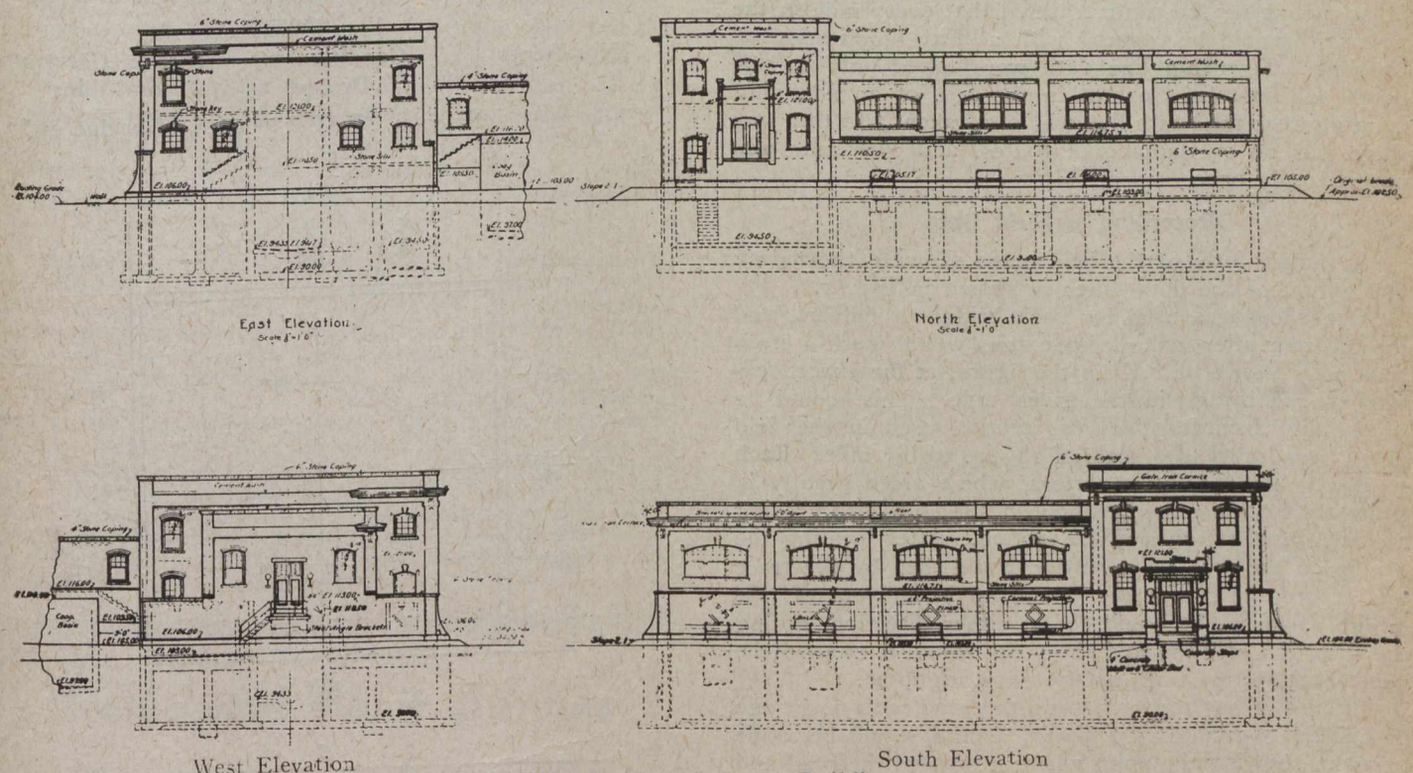


Fig. 4—Elevations of Buildings

An ordinance before the city councils of Philadelphia provides that by December 31, 1924, all water supplied to consumers from the city waterworks shall be delivered through meters and charged for at meter rates. As nearly as may be, a fifth of the present unmetered services would be equipped with meters each year for the next four years, and all remaining in the fifth year. Consumers would pay the cost of supplying, setting, maintaining and repairing meters, but the work would be done and the meters controlled by the Bureau of Water. The ordinance authorizes the Director of Public Works to let one or more contracts for installing the proposed meters, under the terms stated in the ordinance.

A report to the Executive Committee of the American Water Works Association, made by George W. Fuller, Leonard Metcalf and George A. Johnson, shows that returns from fifty plants indicate that labor costs in 1917 were twenty-seven per cent. greater than before the war, while labor has decreased twenty-five to thirty per cent. in efficiency. Construction costs have more than doubled; coal and fuel oil have doubled in price, and chemicals have gone up between fifty and one hundred per cent. The annual increase in revenues has declined below normal, while net revenues, available for capital charges and profits have remained about stationary, as a rule.

METHOD OF NUMBERING COUNTY BRIDGES AND MAKING BRIDGE AND DRAINAGE MAP*

By J. C. McLean

IN order to secure a more complete bridge and road designation the following method has been adopted. This bridge map covers an area of approximately 840 square miles and involved gathering data from twenty-three townships.

Field Work

The county was divided in six districts for the field work, five of which consisted of four townships each, and the sixth the three flat townships along the Missouri River. A field party was placed in each district consisting of an automobile driver, and recorder, together with such tapes, maps, notebooks, etc., as were required for their use. The general plan used in collecting the field data was to take one township at a time and complete it, so arranging the route traveled that every mile in the township would be covered with as little duplication as possible. Township line data were taken only on the north and east lines except in the case of an adjoining county where the south line was also taken. In this way there was no overlapping of routes, and each mile was covered only once.

Recording of Field Data

A sample form of the field notes showing the nature and extent of the data taken is shown in Fig. 1.

One sheet was used for each bridge or culvert, and the recorder after making his entries would mark a cross such as is shown at "A" in the figure, at the exact location of the bridge in the given mile. This could be done quite accurately, as the section used in the field notes was drawn to a scale of 1½ in. to the mile. Each section is divided into quarters, which aided greatly in definitely locating the position in the mile and tracing the streams through a given section. After locating the bridge on the mile the recorder would then by eye trace and record the course of the stream in and out of the bridge as far as he could see in either direction, noting the direction of flow, and the point where it crossed the quarter at section lines as the case might be.

In case of any draw crossing the road with no bridge or culvert spanning it, a similar record would be made to scale, showing the point where it crossed the road and the nature and extent of the drainage.

In addition to the bridge data, all cemeteries, schoolhouses, churches, road changes, ditches, laterals, gravel pits, etc., were recorded in their respective locations and to scale. Taking data of this kind required as a rule between 4 and 5 days per township for one party at a cost of $6 per day for car and driver, $4 for an assistant and about $3 for expenses, making a total cost of $13 per day or between $50 to $60 per township.

Scale, Legend and Numbering

A scale of 2-in. to the mile was adopted for the final map; this size was found to be sufficiently large for the requirements and very convenient for field use. Four symbols were used for the bridge designation as follows:—

Permanent Bridges—Circle with small black square inside and two lines extending through it forming a cross.

Permanent Culverts—Circle with black square inside.

Temporary Bridges—Small black square.

Temporary Culverts—Small hollow square.

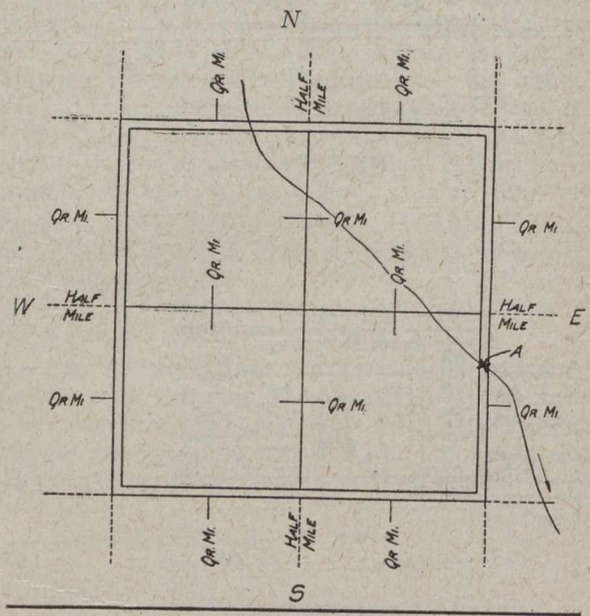
Spans 16 ft. and over were classified as bridges, and under 16 ft. as culverts. It will be noted that these symbols are convertible, for instance a temporary bridge is built and is later changed into a permanent type, this change can be made on the map by simply the addition of two lines and a circle to the temporary symbol. Likewise to change from a temporary culvert to a permanent culvert it is only necessary to fill in the centre of the temporary symbol and inclose it in a circle.

WOODBURY COUNTY, IOWA
Bridge Inspector's Report

191

Township	Drainage Area	Topography
Type	Height Grade to Bed of Creek	Clear Roadway
No. Spans	Total Length of Spans	Length of Bridge
No. Bents	Condition of Bridge	Stream Cutting or Filling

Show in this diagram EXACT location of bridge and Stream



REMARKS

Additional Remarks on Other Side Inspector

Fig. 1—Sample Form of Field Notes

The system of numbering adopted provided each township with a letter of the alphabet as a key which will be used to designate that particular township. The numbering of the bridges began in each case in the northeast corner of the township, thence west on the first tier of sections to the township line, thence east again to the township line, the numbers increasing progressively from the northeast corner. Additional bridges which will be added from time to time will be given the number of the bridge in the section nearest them with numerals prefixed. Thus for an additional bridge near L62, would be L62-1, L62-2, etc. No attempt was made to either number or locate the farm entrance culverts. Where well defined draws crossed the road with no

*Service Bulletin of Iowa Highway Commission.

bridge a number was given them, and a corresponding blank left in the map at this point.

Index of Bridges and Field Sheets.

The data taken on each bridge in the field were transferred in the office to a card index system, classified according to townships. In this way a definite and detailed record of each bridge is kept on file which it has been found greatly facilitates designing new work.

For field purposes a general tabulation sheet of each township was prepared, giving the number, type, length and height of each bridge in the township. This tabulation is printed on the reverse side of the corresponding township map using the duplex system of blue line printing. In this way there is available for field use the general dimensions and types of all bridges in the county. This feature has been found to be very convenient, especially in repair work in determining the length of piling necessary for a given bridge, or the number of floor plank needed.

Office Map

A large wall map has been prepared for office use by assembling the individual township maps on a scale of 2 in. to the mile. On this map will be shown all the waterways in the county fully developed whether bridge or not, and from it it should be possible to obtain with a fair degree of precision the drainage at any particular bridge.

The largest dock in the Mediterranean is to be constructed near Naples. According to the "Giornale d'Italia" the decree has been signed conceding to that city the right of carrying on the necessary constructional works in the harbor of Baia. Among the minor undertakings will be transformation of Lake Averno into a marine basin, with a large industrial zone adjoining the construction of an outer harbor in the Gulf of Baia and of a communicating canal between this harbor and the lake, with a quay provided with all the latest appliances. The total cost is not to exceed L.50 mil., to which the State will contribute L.22 mil. in fifty annual instalments. All the works are to be commenced at latest within six months after the declaration of peace, and to be finished within six years. After sixty years all the works are to become the property of the State without further payment.

POSSIBILITIES OF SALVAGE AND UTILIZATION OF WASTE*

By David Currie
Director-General of National Salvage.

I THINK we have all come to realize in these days what a wasteful nation we have been—how prodigal with our resources! The reason for this is perhaps not far to seek. The bulk of the world's raw materials were at our disposal; we had the money to purchase them and the ships to bring them to our shores; it was far less trouble to use new material than to bother about the old, which was accordingly either thoughtlessly consigned to the scrap heap or ruthlessly destroyed.

We are, I think, naturally an improvident people, and we forgot the first great principle of nature—viz., that matter is indestructible and, properly manipulated, can be used again and again. We invented the word "rubbish" to describe not what was useless, but what we were too indolent to collect and prepare for further use, and thus introduced waste—a word which only has a meaning when the material wasted is of some intrinsic value. We canont waste what is of no value, and therefore by the expression utilization of waste we mean the utilization of material which is of potential value, but which is at present being wasted either by destruction or neglect. The truth of the old saying, "Waste not, want not," is now coming home to us, and we are beginning to realize what an important part salvage can play in helping to win the war, and how still more important it will be in those anxious days of reconstruction which will follow when every scrap of raw material will be required, not only for our own needs, but for the needs of those bruised and battered countries where the monstrous ambitions of the German Apollyon have wrought such rack and ruin.

An Urgent National Need

For years and years, gentlemen, the energies of most European nations will be devoted to salvage in its widest sense, and while the wreckage and waste of war is being cleared away every scrap of material which can be salved will be invaluable, while in the industrial struggle which is bound to come the possession of raw material will undoubtedly prove the dominating factor. Salvage, therefore, is to us as to all other countries an urgent national need, and we must set ourselves with all our hearts and souls to master a subject which has been so carelessly—one might almost say criminally—neglected in the past.

We have only to look around us to realize at once what ample opportunities there are in every direction for organized salvage in this country, and not the least important of these directions is that in which you, gentlemen, are most interested—viz., municipal salvage. I will not stop now to inquire whether this form of salvage pays or not. I am advised that it can be made to pay, and the experience of some local authorities certainly shows that this is so; but at the moment this seems to be a question of secondary importance; and even if salvage is to be carried on at a temporary financial loss carried on it must be, for above everything else at the present time we need the commodities which can be salved and the tonnage which can be freed, and our necessity for these things is so great that they must be obtained even if the result should be a debit instead of a credit balance.

In the United States of America salvage is being energetically taken up by the Food Administration. The

---

*Address delivered at annual conference of Institute of Cleansing Superintendents.

United States Food Administrator has pointed out recently that twenty-four cities of over 100,000 inhabitants are not utilizing garbage and are therefore wasting the equivalent of 4,400,000 lbs. of nitroglycerine and 40,000,000 12-oz. cakes of soap besides enough fertilizer to produce a 3,000,000-bushel wheat crop. Twenty-nine other cities, on the other hand, are saving products worth over $11,000,000 per annum, and a large percentage of these products are being directly used by the government for munition making; but even in these cities there is still being wasted sufficient grease to produce enough nitroglycerine to furnish the powder charge for about 2,000,000 shells of the famous "75's." Three hundred cities of over 10,000 are disposing of their garbage for pig food, and the estimated yield of pork should be 100,000,000 lbs.; but owing to bad methods of separation it is actually only 50,000,000 lbs., worth $8,000,000. On the other hand, 350 cities are not using their garbage and are thus losing 60,000,000 lbs. of pig food annually.

What is France doing? I have seen a report within the last few weeks on the Possible Salvage from Household Waste in Paris. We all know that the Paris "ragpicker" had an European reputation, and he still seems to live up to it, for this report states that with the exception of certain vegetable matter, "nothing escapes from the sorting of a multitude of men, who recover everything that commercial ingenuity enables one to utilize. The intervention of these men begins from the time of the throwing into the streets and is continued up to the incinerator." The problem in Paris thus narrows itself down, says the writer of the report, to the salvage of vegetable waste. So much for our gallant Allies.

Let us turn to a neutral country. In Switzerland the Department of Economics issued in June this year special instructions for the collection of kitchen and garden refuse. The speculative and uncontrolled collection of refuse will be strictly prohibited.

German Methods.

And how about the enemy? Prof. Stephen Leacock, who is the American Lewis Carroll, recently wrote a book in which he described a dream that he was in Germany. In one passage he says: "There were two peasants working beside the road. One was picking up fallen leaves and putting them into neat packets of fifty. The other was cutting off the tops of the late thistles that still stand unwithered in the chill winter air and arranging them according to size and color. In Germany nothing is lost—nothing is wasted. It is perhaps not generally known that from the top of the thistle the Germans obtain picrate of ammonia, the most deadly explosive known to modern chemistry, while from the bulb below, butter, crude rubber and sweet cidar are extracted in large quantities."

This, of course, is a jester's dream, but it is not so very far removed from the grim reality of the waking truth. Although Germany is not putting up her leaves in packets of fifty, it is reported that she is using dried beech leaves as a substitute for tobacco; although she is not using thistledown she is cultivating nettles to obtain textile fibres.

Let us stop for a moment and ask ourselves, "How is it that the Hun, who has been for nearly four years totally—or at least partially—blockaded, who is surrounded by starving peoples, who has cast all his resources, human and material, unreservedly into the business of war, is still able to carry on with vast armies apparently as well equipped as our own, with all the world's markets open to us from which to draw our raw material, and with half the world's factories working overtime on our behalf?

Take the case of clothing, for example. Germany's own production of wool and that of her neighbors is not nearly sufficient for her needs, and possibly of all materials this is one against the import of which Germany has been most effectively blockaded, and yet her armies in the field are nearly, if not quite, as well clad as our own. Quite early in the war optimists predicted that Germany must soon run short of this, that or the other essential, but she is still fighting apparently strong, boastful, and well-equipped as ever. How is it done? By salvage in its widest senses—organized salvage, carefully planned and developed for years as part of her preparations for war.

As the following notes will show, the German is a past master in this science, to which we are only beginning to turn our attention.

In each village in Germany the chief magistrate has the duty to see that the inhabitants of the village bring all their waste material to the official collecting centre; the time at which this has to be done is announced by placards every month or half-month. Every head of a family or head of a household is bound (under pain of punishment) to see that nothing is wasted; everything that seems useless must be collected. The waste material of greatest value is metal—useless cooking utensils of all kinds of metals, worn-out tools and other workmen's implements, ribbons, wire, nails, etc. Among the country people the waste material from the kitchen is used for feeding the animals. The population of the town has, on the contrary, to give up every kind of waste from the kitchen daily. For instance, it is obligatory to remove the grease from plates and dishes by heating them and washing it off with a very little water, which is then collected in pails. Statistics showed that in Berlin 4,000 to 5,000 kilos of fat were obtained daily from the collection of rinsing water (in the town alone). This fat is used for lubricating grease and for the manufacture of soaps.

The skins of all kinds of small animals (hares, rabbits, etc.), every kind of hair, feathers, etc., must all be collected. In the larger towns carts and motors have been organized for this purpose, and these go round to each house every day in the morning at a fixed hour, at which time the inhabitants must bring the waste material down and empty it into the carts. In Berlin and the other big towns the whole business must be finished before 7 a.m.

As the slaughtering is under State control, and takes place in the bigger towns only in big slaughter-houses, special appliances have been invented which catch all the waste, such as blood, hair, etc. The rare home slaughtering which takes place in the country is also under the supervision of the magistrate, and here also all the waste must be collected.

Special arrangements have been made for transporting the corpses of animals which have died of disease to special factories, where they are immediately put into use. The work is done without any smell, as the whole apparatus is heremetically closed. A whole body can be thrown into the dissolving oven. Fat is obtained first of all by this process; then gelatine (glue), and other stuffs which are used in various branches of industry. There is another apparatus which concentrates and utilizes the gases of putrefaction. The remainder of the corpses is used for chemical manures.

In order to obtain oil, all the pips and kernels of fruit, especially peaches, plums, and apricots, are collected—and also the pips of apples and pears. The school-children are particularly used for such collections. Not a kernel

or a pip may be thrown away. The official collectors have had advertisements put up in all public buildings, restaurants, stations, etc., to the effect that everyone is to collect the stones and pips, and is to bring them to the collecting centres, mostly instituted in the schools or in the municipal buildings. The school-children are used also to collect acorns and beech nuts; beech nuts make very good salad oil. The collecting centres at Stuttgart published a report in 1917, according to which 150,000 kilos of oil had been extracted from the fruit kernels, acorns, horse-chestnuts, and beech nuts collected by the school-children.

Possibilities of Municipal Salvage

Let us now return to the question of our own salvage, particularly municipal salvage.

The subject is a very large one, and may be dealt with under three heads: (1) What kind of material and what quantity is at present being wasted? (2) How can it best be salved? and (3) How best utilized?

It would be impossible for me, even if I were able to do so, to deal fully with each of these branches of our subject, and I propose to deal only with the first, leaving the second and third to those who have actually been doing them, who therefore know the difficulties and the possibilities from actual experience, and are far more competent than I am to deal practically with the problems of collection and utilization.

I propose, gentlemen, to confine myself to what I shall call the Possibilities of Municipal Salvage.

The quantity of refuse which is "made" annually throughout the country I have estimated at 9,450,000 tons. This figure is based on an allowance of 15 cwts. per 1,000 of the population during 300 days in the year, a figure which is, I think, below the average of the amounts actually collected in most parts of the country. Whether we are justified in applying a figure obtained from the records of towns and cities to the country generally is a matter I shall deal with later, but I would just remind you here that it is the make of refuse which we are at present considering, and not its collection, and there is no apparent reason why the make of refuse should be any less in rural districts than in urban areas.

And now, as to the nature and composition of this refuse. This I have based on actual results obtained by the authorities of Accrington, Bury, Hackney and Sheffield, each of whom have had a careful analysis made of bulk lots of ordinary refuse such as would have in due course been passed through the destructor. The following table shows the average results, and what they represent if applied to the refuse of the country generally:—

Analysis of "Refuse"

Commodity.	Analysis of refuse in Sheffield, Accrington, Hackney and Bury. Average Percentage	Applied to population Great Britain, assuming 15 cwt. per 1,000 population per day during 300 days annually = 9,450,000 tons.	
Fine dust	50.98	4,817,610 say	4,800,000 tons
Cinders	39.63	3,745,035 "	3,700,000 "
Bricks, pots, shales, etc.	5.35	505,575 "	500,000 "
Tins	0.98	92,610 "	90,000 "
Rags	0.40	37,800 "	37,000 "
Glass	0.61	57,645 "	50,000 "
Bones	0.05	4,725 "	4,000 "
Vegetable matter	0.72	68,040 "	68,000 "
Scrap iron	0.06	5,670 "	5,000 "
Shells	0.08	7,560 "	7,000 "
Paper	0.62	58,590 "	58,000 "

These figures may appear to be somewhat fantastic, but I can assure you, gentlemen, that they are founded on facts and are within the bounds of reasonable possibility. Some of you may perhaps say, "The conditions in these towns or cities must be most unusual. I am sure that my refuse is nothing like so valuable." Well, gentlemen, I can only advise you to go back home and make sure. Our first test was made in Sheffield, and the results surprised us, but when the results of the other three came in they all bore out the Sheffield figures. I may say further that several other authorities who have since at our request analysed their refuse have obtained in every case at least similar and in some cases even higher results.

METHODS OF WATER WASTE ELIMINATION IN A 100 PER CENT. METERED CITY*

By H. P. T. Matte,
Superintendent Water Department, Oak Park, Ill.

OAK Park, Illinois, has always been fully metered. All water pumped into the distribution system saving that which is lost through underground leakage, is passed through meters. Furthermore, there is no free water.

Maintenance of Meters

All meters are tested periodically, a practice which has been found profitable, although not required by the Public Utilities Commission. Meters are read every quarter in a continuous reading system, for which purpose the city is divided into six districts so that those found to be not registering can be brought into the shop, repaired and put back into service within a week after being read.

Rigid Collection of High Bills Due to Leakage.

This point is important and has a beneficial effect on the success of the meter system. In other words, although it may be hard on the consumer, he will, if properly impressed, appreciate the importance of watching his fixtures and become educated in spite of himself.

No reduction in bills is made on account of leakage. Short and pointed instructions, which include the policy of the Water Department, are printed on the backs of the water bills. If the complainant has been guilty of the characteristic failing of mankind, that of being unobserving and neglecting to read the information supplied to him every three months, he deserves to pay for his inattention.

This does not mean that the department is heartless and does not admit mistakes. The consumer is given the benefit of the doubt from the first, owing to the fact that the department realizes that it is but human and can be in error in several ways. In fact, the department lets it be known that it is glad to correct its faults. If, however, upon thorough investigation it is found that the water was consumed through leakage or otherwise wasted, the bill must be paid. In order to be fair certain allowances are made if the waste was in the ground and invisible. In this case the lowest rate at which water is sold in Oak Park is allowed, although the quantity consumed may not justify the consumption to be placed in that class.

In any case of high bills, whether this concession is given or not, if the consumer is plainly unable to pay the bill as it stands (these claims being investigated), an installment plan of payment is adopted; but with the provision that the bill must be paid within a year.

*Abstracted from paper read before the Illinois Section of the American Water Works Association.

The reason for this attitude is this: Every student of human nature knows that if a water department is reputed to be lenient, the average person takes a chance and depends upon his ability as a bluffer to get out of paying the bill. Talk is cheaper than plumbing bills. If he is victorious because "he has been unfortunate and won't let it happen again," he surely will. In the old days of leniency it was found that the average consumer did do it again.

Complaint Department

But it is impossible to handle this matter properly without an efficient complaint department, for it is then impossible for the department to prove its case. Every waterworks man who has had to deal with consumers under the meter system is aware of the number of excuses and prevarications that are evolved in order to make the management believe that there was a mistake made in the reading, that there are no leaks, that the fixtures have been repaired recently, that the meter works when no water passes through it, that the meter reader is in collusion with the "bunch of grafters in the office" and reads the meter from the next block, and so on.

Oak Park, however, is prepared to prove to all these amateur lawyers that they have no case in court. There is a record of all complaints of whatever nature that have been made to the water department and about the water department for the past five years. These are arranged by years in 3- by 5-inch card files, and are the original records. All calls are recorded on the same size cards, three colors being used to distinguish between complaints relating to meters and bills, complaints and job orders relating to the mechanical division, and those relating to delinquent bills. This record is very valuable in refuting unjust accusations, in tracing past records, and for the purpose of settling especially difficult problems.

All complaints concerning high bills are investigated and a comprehensive written report is made to the consumer. The nature of the complaint is written on the card provided for that purpose and is given to an inspector who makes a specialty of investigating high bills. It has been found impracticable for the meter reader to waste time making investigations. He notes all unusual sounds or evident leakage on the reading slip and a special call is made. Sometimes a consumer is dissatisfied even after a second investigation, and he is allowed to hold the payment of the bill until the next quarterly statement, when he will see for himself the result of stopping small leaks. If, however, a rebate is yet expected or sought, a final notice of "shut off for non-payment" is issued and the water is shut off in spite of threats of litigation.

For the purpose of determining the cause of persistent high bills, where "there are only two in the family, no leaks, and there is no sprinkling done; while the family next door has three or four children, does its own washing, sprinkles the lawn all day, and has only minimum bills," the department has evolved a recording detector which is substituted for the meter and which gives a graphic record of the consumption for 24 hours or a week. It is thus possible to spot the number of times the faucets are opened, the number of baths with the quantity used each time, and the number of times the toilets are used. It has thus been possible on many occasions to show that the toilet would not work about every fifth time it was operated, and that the lady of the house was apparently too clean, having the habit of letting the water run in the kitchen sink too long each day or that somebody took a cold bath every morning and consumed about 50 gallons each day in the operation, or that a thermostat used by a central heating plant leaked at some time during the day, or that the toilet was used too often to wash down foreign substances that did not belong there, or finally that the servant was very wasteful.

The complaints on account of high bills dropped in number from 2,000 in 1913, to 600 in 1917, due to the education of the consumers who, realizing that the department means business, is strictly impartial and is able to help them reduce their water bills, have begun to cooperate with the department.

Recording Pressure Gauges and Master Meter

The third item in the efficient elimination of waste is the installation of recording pressure gauges and a master meter directly on the distribution system. The combination of the two devices is a great aid in estimating the rate of consumption during the night, which is due to leakage alone, in noting the progress each day in the stoppage of leaks, and in determining the necessity for making a special waste survey. The efficiency of the pumping station attendants as well as that of the pumps can be determined at a glance. Many plants are equipped with Venturi meters or pitometer recorders placed on the main leading to filter beds, or to reservoirs or standpipes. The character of the consumption cannot be accurately determined by meters so placed that the fluctuations cannot be seen.

Periodical Waste Surveys

The waste survey is one of the most important elements in the prevention of continued needless waste on a metered water system.

In order to shorten the work of making waste surveys and avoid unnecessary work, it is advisable to make first a rough survey of the entire city with a pitometer, which is done by isolating certain districts and measuring all the water consumed through one of the mains as a feeder. Here is where the master meter on the distribution system comes into use. The Oak Park department often shuts down large districts for a few minutes and notes the drop on the Venturi chart. It is impossible to do this at night because the quantity is only 400 gallons per minute between the hours of 1 and 4 a.m. In fact, the smallest pump is so throttled in order to maintain the assumed pressure of 40 lb. that the opening left is equal in area to that of a 2-inch pipe. The Venturi meter is not sensitive enough at that low velocity; but it is possible to accomplish nearly the same result in the day time during periods of steady consumption when there is a draft of 2,000 or 3,000 gallons per minute. In this case the drop has been found sufficient to allow the making of an analysis of the leakage conditions. The pitometer is the surest way, however, for it is possible with it to obtain accurate information and so eliminate the "good districts."

After the pitometer survey, especially when the leakage is so small that there is little velocity in the mains, the "hydrant and hose method" follows logically. It is practically useless to expect any headway if a displacement meter is used, as the rate of consumption and the minimum flow cannot be accurately determined. The Oak Park department uses a 2-inch Venturi meter, but a pitometer inserted into a short piece of pipe 2 inches or smaller in size is as good. A manometer and as much condemned fire hose as can be obtained from the fire department completes the outfit.

During the summer of 1917 the department tested 18 miles of mains, and stopped leakage amounting to 220,000 gallons per day. This represents a saving in the cost of water purchased from the City of Chicago, of $5,000 and the outfit used cost only $150, exclusive of the hose. It also accomplished the reduction of the night

(Concluded on page 358)

SELECTING AND SHIPPING SAMPLES OF NON-BITUMINOUS ROAD MATERIALS*

By Prevost Hubbard† and F. H. Jackson, Jr.‡

THE following directions for selecting and shipping samples of non-bituminous materials should be followed in connection with materials which are to be tested in the laboratory for conformity with the foregoing specifications. It should be noted that most of the tests for size or grading of broken stone, slag, gravel, sand, etc., may and should be made frequently in the field or at the plant with a set of screens or sieves and a rough balance.

General Directions.—(1) Samples should be taken so as to represent as nearly as possible an average of the bulk of material sampled, and in case of principal materials for the higher types of roads, they should also be selected with a view to ascertaining the maximum variation in characteristics which the material may possess. (2) Samples should be packed in such manner as to withstand rough shipment, and special precautions should be taken to prevent the obliteration or removal in transit of tags or identification marks. (3) Notification of shipment of samples, with statement of identification marks and such other descriptive information as may be necessary should be promptly forwarded to the laboratory.

Information Accompanying Samples.—Whenever possible, the following information should be furnished the laboratory in connection with each sample submitted:—

1. Identification mark.
2. Name of material.
3. Name and address of producer, or owner of deposit.
4. Location of plant or deposit.
5. To be examined for conformity with ——— specification.
6. Name and location of road where material is to be used.
7. Proposed use and type of construction in which material is to be used.
8. Date sample taken.
9. Place sample taken.
10. Sample taken from (quarry, crusher, bin, pit, plant, car, storage pile, or mixer).
11. Quantity represented by sample.
12. Material shipped in car No. ——.
13. Date material shipped.
14. Date material received at destination.
15. Date used or to be used if satisfactory.

Time and Plant of Sampling.—(1) Whenever practicable, non-bituminous materials should be sampled at the place of occurrence or manufacture at such time as to allow the test controlling acceptance or rejection to be made in advance of shipment. (2) When impracticable to take samples as above mentioned, they should be taken from the shipment immediately upon delivery. (3) Samples should always be taken when the appearance or quality of the material changes.

Broken Stone

Sampling for Quality.—When tests for physical properties are required, a preliminary sample should be taken from each proposed source of supply at least two weeks before final acceptance. The preliminary sample may, however, be omitted in cases where material from a well-known source of supply has been tested within one year previous to the date of acceptance or rejection. In such case the report of the last previous test may be used as the basis of acceptance or rejection. Mixed samples may be taken when deemed necessary. Each sample should weigh at least 25 pounds and be composed only of sound interior rock strictly representative of that which it is proposed to use. The fragments should be 2 inches in size or larger. In addition, one piece which should measure at least 3 by 4 by 6 inches will be required if a toughness test is to be made. This piece should be free from seams and cracks, and should have the bedding plane marked if practicable. Samples should be shipped in tight boxes or heavy burlap bags.

Sampling for Size or Grading.—Broken stone may be sampled for size at the crusher, from bins, cars, or storage piles on the job. A composite sample composed of samples from different parts of the supply is advisable. Samples should weigh not less than 10 pounds for material containing fragments ¾ inch in diameter. Samples of larger aggregates should increase in size up to about 60 pounds, depending upon the diameter and weight of the largest fragments present. When laboratory tests for size are required, samples should be shipped in tight boxes or heavy close canvas bags.

Broken Slag

Sampling for Quality.—Slag should be sampled from the crusher or that portion of the dump which it is proposed to use, at least two weeks and not more than one month before final acceptance. Additional samples should be taken during progress of the work, whenever the quality or appearance of the slag changes, and at such other times as may be directed. For the French co-efficient of wear determination, each sample should weigh at least 25 pounds and be composed of fragments 2 inches in size or larger. Samples of approximately 100 pounds of each size will be needed for determinations of weight per cubic foot, but such test should ordinarily be made at the crusher or on the job. Tight boxes or heavy burlap bags should be used as containers when shipping samples of slag.

Sampling for Size or Grading.—The same directions given under broken stone apply to broken slag.

Gravel

Samples of pit run gravel proposed for use in water-bound gravel road construction should be taken at least 10 days and not more than 6 months prior to the date of acceptance or rejection, and, if from an accepted source of supply, whenever, during the progress of the work, the gravel appears to change markedly in either quality or grading. Great care should always be exercised in sampling a gravel pit to insure obtaining material for test which is strictly representative of that which it is proposed to use. A number of samples may be taken from a single pit if necessary to cover the probable range in grading of the available material. Samples of pit run gravel should weigh from 50 to 75 pounds.

Samples of screened gravel may be taken at the plant, from bins, storage piles, barges, or cars. A composite sample composed of samples from different parts of the supply is advisable in order to determine the average composition of the material. Every shipment of gravel for bituminous concrete or Portland cement concrete should be sampled, in which case no single sample should represent over 100 cubic yards. Samples should weigh from not less than 10 pounds, for material containing fragments up to ¾ inch in diameter, up to 60 pounds, depending on the size of the largest fragments present.

Shipment of samples should be made in tight boxes or close-woven cloth bags.

*From "Typical Specifications," issued by U.S. Department of Agriculture.

†Chemical Engineer, U.S. Bureau of Public Roads.

‡Asst. Testing Engineer, U.S. Bureau of Public Roads.

Sand

Before approving a source of supply, samples of sand should be taken at least 10 days prior to the date of acceptance or rejection. Pit samples should be taken only from freshly exposed surfaces, and the number of samples from any given deposit should be sufficient to cover the extreme range in quality of that portion of the deposit which it is proposed to use. Every shipment of sand for bituminous concrete, Portland cement concrete, or grouting, should be sampled, and no single composite sample should represent over 100 cubic yards. Additional samples should be taken whenever the appearance of the sand changes. In the case of sand for sheet asphalt, frequent samples should be taken daily at the plant from the drum or bin.

Samples of sand should weigh approximately 10 pounds. They should be shipped in tight boxes, case, or close-woven cloth bags.

Mineral Filler

Each shipment of mineral filler should be sampled. When shipped in bags a composite sample should be prepared from one sample taken from each 20 bags in the shipment. A 1-pound sample may be submitted for examination shipped in a tight box or can.

Total Mineral Aggregates

When the grading of the total mineral aggregate for bituminous concrete or binder course is specified frequent samples should be taken daily at the plant from the drum or bin. Such samples should weigh approximately 10 pounds and if shipped should be placed in tight boxes or cans.

Sand-Clay or Top Soil

Before approving a source of supply samples of natural sand-clay mixtures, top soil, sand, or clay, should be taken at least 10 days prior to the date of acceptance or rejection. The number of samples from any given deposit should be sufficient to cover the extreme range in quality of that portion of the deposit which it is proposed to use. Additional samples should be taken whenever the appearance of the material changes. When an artificial mixture is made on the road fragment samples of the finished mix should be taken. Samples should weigh approximately 10 pounds and if shipped should be placed in tight boxes or cans.

Portland Cement

Either individual or composite samples of cement may be submitted. Samples should be taken either at the mill or from cars. Individual samples from cars should represent not more than 50 barrels. If taken from bins, each sample should represent not more than 100 barrels. Composite samples taken from cars should be made up of a sample from 1 sack in each 40 sacks, or 10 barrels combined to form one sample. Composite samples taken at the mill may be either from the conveyor delivering to the bin, in which case one sample of 8 pounds should be taken from each 100 barrels passing over; from the bins themselves by means of proper sampling tubes, provided samples are taken from points well distributed over the face of the bins; or from the bins at the point of discharge, provided sufficient material is drawn from each discharge to obtain samples representative of the material in the bins. In no case should a single composite sample represent over 200 barrels. Samples should be shipped and stored in air-tight containers. Before testing, they should be passed through a 20-mesh sieve in order to thoroughly mix the sample, break up lumps, and remove foreign material.

Paving Brick

Samples of vitrified paving brick may be taken at the point of manufacture or from cars at the point of delivery. Samples from the plant should preferably be taken from the kiln at the time of emptying. One or more sets of tests, depending upon the size of the kiln, each set consisting of three separate tests, should be made on each kiln. Each test in a set of three should represent approximately a single degree of burning (based on the position of the brick in the kiln), and all 10 of the brick in a single test should be of the same approximate degree of burning. In general, samples selected from piles at the plant should be as nearly as possible representative of the entire run of the brick. Samples from piles should be taken from as many different points corresponding to the length, breadth and depth of the pile as possible. In no case should they be confined to the upper or outer few layers. Where controversy arises regarding the admissibility of certain types or portions of the lot, entire test samples may be selected from such types or portions having a characteristic appearance in common. When sampled at the point of delivery, a representative sample should be taken from each carload received. Considerations covered under sampling from piles at the plant apply equally to sampling from cars. No bricks should be included in the test lot which would be rejected on the basis of cracks, chips, or other defects covered by the specification clauses for visual inspection. Samples should be shipped in stout boxes or crates in lots of 12, put up in 2 rows of 6 bricks each, separated by a wood partition.

Stone Block

Stone block may be sampled for quality and size either at the quarry or from cars. A preliminary sample for quality consisting of at least four standard blocks should be submitted from each proposed source of supply at least two weeks prior to the date of acceptance or rejection. Additional samples of blocks may be taken from time to time during the progress of the work, whenever the quality or appearance of the blocks varies, and at such other times as may be directed. No sample should include blocks which would be rejected on visual inspection. Preliminary samples may be omitted in cases where material from the proposed source of supply has been tested within one year prior to the date of acceptance or rejection, in which cases the report of such tests may be used as the basis for acceptance or rejection. Samples of stone blocks should be shipped in stout boxes or crates.

CONSTRUCTION FEATURES OF CONCRETE SHIPS*

By R. J. Wig and S. C. Hollister

The Concrete.—The concrete must be durable and impermeable to water; it must have a compressive strength of at least 4,000 lbs. per square inch at 28 days, and a minimum weight. To meet these conditions we have determined upon the use of a rich mortar mixture. Any standard Portland cement which will meet the specifications of the United States Government may be used, provided the fineness is increased so that at least 90 per cent. will pass a No. 200 sieve. For the present the maximum-size aggregate is limited to ½ inch. A sand and gravel or a volcanic ash or specially burned clay may be used.

The commercial future of the concrete ships is in large measure dependent upon obtaining a lightweight concrete. The strength and weight of one of these mixtures which meets our requirements is as follows: 1 part cement to 1 part special fused clay below ¼-inch size to 2 parts same aggregate between ¼ and ½-inch size, had a compressive strength of 3,380 lbs. per square inch at 7 days and 4,350 lbs. per square inch at 28 days. It weighed 106 lbs. per cubic foot in a saturated condition. With the use of this material the ratio of the dead-weight to total displacement will be 62 per cent. for the 3,500-ton ship as compared with 65 to 68 per cent. for a steel ship and 53 per cent. for a wood ship. No integral waterproofing compounds of any kind will be used in the mixtures.

Reinforcing Steel.—Reinforcing steel which we are using, other than fabric, is of rods or bars rolled from new billets to conform to the American Society for Testing Materials standard specifications for structural grade new billet steel. Plain round bars will be much easier to fabricate than deformed bars, but on account of the uncertainty of the effect of reversal of stress we are using deformed bars wherever the bond stress is high. The accurate bending of the reinforcing is one of the most difficult of all the construction problems. With a wall thickness of only 3½ to 4 inches, and two to three layers of steel, need for accurate bending of the steel can be readily appreciated. Furthermore, the curvature is constantly changing forward and aft in the vessel, which requires constant change in the location of the dogs on the bending table. The use of small steel is recommended, in that it is easier to spring into place if the bending is not accurately done.

With a very large quantity of steel, approximately equivalent to 10 per cent. of the carrying capacity of the ship, to be placed in a very small space in thin walls, there is much opportunity for the development of ingenious methods of fabricating the steel. Undoubtedly much time can be saved by pre-fabricating, at least in part, the steel of the frames and placing them in the ship as units. These frames may be as much as 54 feet in width and 35 feet in height, and they must be accurate to within a fraction of an inch. Through a length of 60 per cent. of the ship the shape of these frames is constantly changing. All the steel must be supported and secured so that it will not touch the form surface. Numerous methods have been suggested, and there are a number of chairs now on the market for supporting steel, but all of them have objectionable features.

A study has been made of welding methods and machines as a means of avoiding the lapping of the steel. The acetylene weld is rather uncertain and not satisfactory. The electric resistance weld appears to be the most promising and several machines of this type have been ordered and are now being tried out. It is not anticipated that welding any steel other than the main steel of the frames and possibly the main longitudinal steel will be required.

Mixing and Placing Concrete.—Rich mortar mixtures will be used, and they must be carefully proportioned and mixed in order to insure the quality of concrete necessary. Special attention should be given to the selection of the mixer, as all mixers of common types will not thoroughly mix mortars. The concrete should not be transported from the mixer and deposited directly into the forms in continuous operation or in large batches, on account of the danger of not having it thoroughly worked into place about the reinforcing steel. For the present it is required that all concrete shall be shoveled into the forms in order to insure its deposit in small batches and its thorough working into place.

It is preferable to place the concrete as one continuous operation in order to avoid construction joints. This will require approximately three days (of 24 hours each) for a 3,500-ton ship and six days for a 7,500-ton ship. No trouble is anticipated in working the concrete thoroughly around and through the reinforcing. The rich mortar mixture proposed is quite fluid, even though it is not mixed to a wet consistency, and with a slight tapping of the forms it settles readily into place about the steel. A number of test panels have been made, and the results in all cases have been entirely satisfactory. It is very different to make a construction joint in a section in which is embedded a large quantity of steel. Most leakage troubles occur at construction joints. The uncertainty of the bond obtained at construction joints is also objectionable on account of the large shear stresses. Several mechanical methods of placing mortar and concrete have received consideration, but the results of investigations do not up to the present warrant their use.

Durability of a Concrete Ship?—If durability is to be obtained, special attention must be given to many elements of the ship. The most serious problem is to provide means of adequately protecting the steel from corrosion. There is a large quantity of steel embedded in the concrete and much of it cannot be covered by more than ⅝ inches of mortar. This of itself will not protect the concrete, particularly in the interior and in the upper portions of the hull. There are two means of allaying, if not wholly preventing, the corrosion of the steel. The steel may be galvanized or painted with some protecting medium which will not appreciably affect the bond, or the concrete may be coated with some thoroughly impervious membrane which will prevent both air and water from reaching the steel. A large number of tests are being made, and it is quite possible both methods of protection will be tried. The results are promising and a satisfactory protection should be developed.

Another possibly disintegrating element which may have great importance is the effect of constant reversal of stress, as the ship alternately is subjected to hogging and sagging stresses in a heavy sea. Our allowable steel stresses are such as to cause the concrete to crack. No trouble from chemical disintegration is anticipated except as the hull may be seriously abraded. Sugar and certain vegetable oils, such as the cocoanut and peanut oil, will disintegrate the concrete if it is exposed for an appreciable length of time. If the ships are to be used in this class of trade, a protective paint coating should be applied to the inner surface of the hull.

*Abstracted from paper read before the American Concrete Institute.

The Concrete Ship Department estimates the life of the concrete ship without any special protection at several years, and known methods which can now be applied should extend the life several years longer. It believes adequate protection will be developed to insure reasonably permanent life to the concrete ship.

The economy of the concrete ship cannot be determined until we have had experience over a term of years. The estimated cost of the concrete ship at the present time is approximately $125 per ton dead weight. The cost of a steel ship averages about $200 per ton, and that of a wood ship, $165 per ton dead weight.

If proper coatings can be developed to prevent deterioration, the concrete ship should be a competitor of the steel ship. With further experience it is believed the weight of the concrete can be very materially reduced, thus making the cargo capacity more nearly equal to that of the steel ship

"FLU" DELAYS LEGISLATION DISCUSSION

ON account of the epidemic of "Spanish" influenza, the meeting of the Engineering Institute of Canada, Montreal Branch, which was to have been held last Thursday evening in Montreal, was cancelled by order of the Montreal Board of Health. The meeting would have been the first of the season and had been called to discuss the following questions:—

Is there need for legislation defining the legal status of the engineer, and prohibiting unqualified persons from practising as engineers? If so, what form should such legislation take and how could it be secured?

"The western branches of the Institute have had full discussions on these matters," said Frederick B. Brown, secretary-treasurer of the Montreal Branch in the circular letter calling the meeting, "and it is expected that provincial legislation will be sought in Saskatchewan this year. The matter is important to every member of this branch, and to the Institute.

"Arthur Surveyer, chairman of the Legislation Committee of the Institute, will open the discussion by presenting a statement of the existing situation, and of the proposals now being put forward by sections of our membership, and prominent members of our branch are expected to take part and to present different viewpoints.

"In order to enable the executive committee to prepare a programme, you are requested to notify me by an early mail if you intend to speak, and to state generally whether you approve or disapprove of legislative action. The discussion will be open to all members. Realize that legislation may affect your interests."

Mr. J. C. McIntosh, M.P. for Nanaimo, upon his recent return to Victoria, confirmed the report that the Federal government is to embark on a steel shipbuilding programme on Vancouver Island. The site of the yard, he said, will be somewhere in the Nanaimo district, and the machinery is to be assembled in Victoria. The undertaking will mean the expenditure of over $15,000,000.

The following is a statement of shipments of ore from Cobalt Station, in pounds, for the week ended October 4, 1918:—

Peterson Lake, 60,000; O'Brien, 64,010; Penn-Canadian, 66,000;. National, 76,292; Mining Corporation, 129,389; McKinley Darragh, 211,609; Buffalo, 176,000; Nipissing, 129,502; total, 912,802.

The total shipments since January 1st, now amount to 22,817,435 pounds, or 11,433.7 tons.

GOOD ROADS IN BRITISH COLUMBIA

DELEGATES from all parts of the province attended the annual convention of the Good Roads League of British Columbia, held last month at Penticton, B.C.

The value of tourist traffic was emphasized. It was stated that over $700,000,000 is spent every year in the United States by tourists. Much of that money is available to people who go after it, and the most important of all methods of securing tourist traffic, is making roads so good that tourists want to motor over them. Over $7,500,000 has been spent by automobile owners in their travels in the Pacific Northwest, and, with the development of roads in British Columbia, a very much greater sum would be spent there.

The problem of transportation, one speaker pointed out, goes to the very root of the development of the province, and the same speaker further maintained that the provincial government is sympathetically alive to that fact and ready to do everything possible to further the good roads cause.

Among the resolutions passed was one calling for a change in the rule of the road, to make the British Columbia rule conform to that of other provinces. Other resolutions were carried as follows:—

Requesting that a section of road be constructed from Rossland eastward to Trail, Brilliant and Thrums; that the provincial government make an investigation of the feasibility of the various routes for the proposed trans-provincial highway before any action be taken; that all horse-drawn vehicles be obliged to carry lights; that the governments put all alien enemies, interned and otherwise, at work.

Mayor Gale, of Vancouver, pointed out the futility of passing resolutions, if they are not followed up, and suggested that a memorial be framed embodying all the resolutions, and that this memorial be circulated for signatures, in order that the provincial government could be shown that there is a solid electorate back of the roads movement. The mayor's suggestion was adopted.

WAGE INCREASES ON CANADIAN ROADS

Seventy-five thousand stenographers, clerks, office boys, messengers, watchmen, section men and others in the employ of the Canadian railways were granted an increase in wages amounting to more than 22 million dollars a year on the present pay-roll, at a meeting of the Canadian Railway War Board. At the same time, in view of the demands of organized labor, it was ordered that hereafter the eight-hour day shall prevail in all Canadian railway freight sheds. Instead of opening at 7 a.m. and remaining open until 5.30 and 6 o'clock, the sheds will now open at 7.30 o'clock and close at 5 o'clock for five days in the weeks, while on Saturday the closing hour shall be 1 o'clock. This goes into effect October 15.

The meeting at which the two important decisions were reached began at 2.30 in the offices of the Canadian Railway War Board, which by 5 o'clock had made its decision. Following the lines of supplement 7 to general order 27 of the United States Railway Administration, which the Canadian Railway War Board undertook to adopt in Canada on July 15 last, an increase of $25 per month will be given every employee in the classes referred to. Some of these increases will date from September 1 and some from October 1. This is in lieu of the former somewhat complex scale of increases provided by the McAdoo scheme. Instead of adding a percentage to the wage paid for a certain kind of work on December 31, 1915, the lump sum referred to will be added to the wage paid on January 1 of this year. Slight questions as to the interpretation of the wording of the McAdoo award in this respect still remain to be settled.

Welland Ship Canal

Recapitulatory Notes on Canada's $50,000,000 Waterway Between Lakes Erie and Ontario—Some Data On That Portion of the Undertaking Contracted For and Partly Executed Prior to Suspension of Operations

By J. GARNAR FLOOD
Formerly Engineer for the Contractors

ONE of the direct effects of the war on public enterprise in Canada has been the suspension, since the end of 1916, of all active work on the Welland Ship Canal, the date of the resumption of which is at present a matter of pure conjecture. That the project will later be revived is almost certain, considering the fact that over twenty million dollars have already been spent. Until the end of the war is, at any rate, in sight, it would be premature to speculate on just when work will be recommenced. The Welland Canal now in use has, since its construction, been known as the "new" canal, in distinction from the original waterway which is now historically referred to as the "old" canal, commenced in 1824. The work now in course of construction, therefore, constituting the third undertaking of the kind, but with the distinction of being known to the world as the Welland Ship Canal.

The conception of this new undertaking, and a general description of the work involved, having already appeared in "The Canadian Engineer," the object of the present article is to discuss, more especially, that portion of the undertaking which, for over three years, was the scene of so much activity, but which, to-day, is lying dormant and deserted, until time and circumstances warrant its further exploitation.

The route of the Ship Canal, as finally located, follows the course of the present canal from Port Colborne, on Lake Erie, to Allanburg, half way across the Niagara peninsula. From this point an entirely new cutting is to be made, crossing and re-crossing the present canal, until it finally enters Lake Ontario, at the mouth of the Ten-mile Creek, about three miles east of Port Dalhousie, the entrance to the present canal. For construction purposes, the work has been divided into nine contract sections, Section No. 1 being at the Lake Ontario end of the canal, the other sections following consecutively toward Lake Erie. Up to the present time, contracts have been let for, and active work conducted on, Sections 1, 2, 3, 5, together with a portion of Section 4, called 4A, which combination entirely covers the ground under discussion.

Section No. 1

Contractors.—The Dominion Dredging Company, Limited, of Ottawa, Ont.

Approximate Amount of Contract.—$3,500,000.

Work Contracted for.—Construction of harbour for new Lake Ontario entrance to canal, comprising 25-foot dredged channel, 1½ miles long; construction of reinforced concrete entrance piers, retaining walls, etc.; excavation of 1½ miles of canal prism inland; construction of Lock No. 1, with weirs, regulating pond, etc., and the substruction for Bridges Nos. 1 and 2.

Dredging and Excavation.—At the time of the suspension of operations, over 1,000,000 cubic yards of earth excavation had been removed, and 40,000 cubic yards of rock, the material all being disposed of in the harbor embankments. The material to be dredged proved to be of a very hard nature, consisting for the most part of firmly cemented sand and clay, and, for a distance of approximately 1,700 feet, rock was encountered about three feet above the grade line. To cope with the work, the contractors found that large capacity dipper dredges did the best work, and two such dredges, of 5- and 6-yard dipper capacity, respectively, gave a good account of themselves, until the spring of 1915, when they were assisted by the C. S. Boone Dredging Company, sub-contractors for a portion of the dredging, who started another 5-yard dipper dredge, and a drill boat equipped with three steam rock drills, for drilling blast holes in order to loosen the material ahead of the dredges. For dry excavation, the plant included two steam shovels,

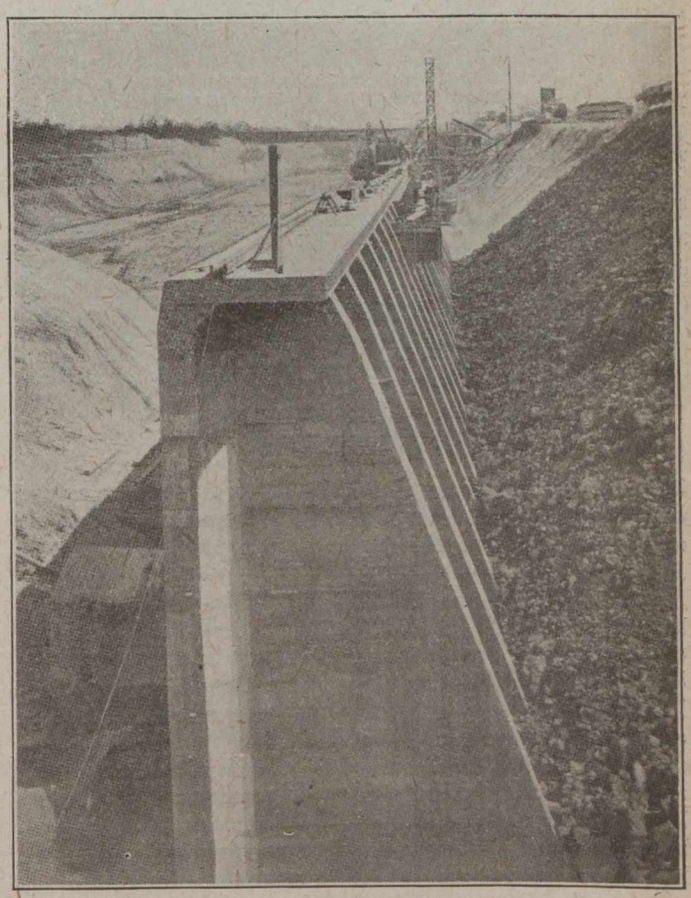


Fig. 1—Reinforced Concrete Wall, Lock No. 1 being Backfilled

one dragline excavator, one 15-ton locomotive crane, locomotives, dump cars, and spreaders.

Reinforced Concrete Cribs.—The reinforced concrete cribs, of which the outer entrance piers and the docking of the east and west side of the inner harbor are formed, were constructed at Port Dalhousie by the J. H. Tromanhauser Co., Ltd., of Toronto, sub-contractors for the Dominion Dredging Co., Ltd., and have already been described in detail,* both as to design and method of

**The Canadian Engineer*, April 8, 1915.

construction. The specifications originally called for 55 cribs, but the general lay-out of the harbor having since then been modified, the number has been reduced. Each crib contains 934 cubic yards of concrete and 112,000 pounds of reinforcing steel, and weighs approximately 2,000 tons, with some slight variations in the case of some corner cribs, and a few cribs at the outer entrance, which were more heavily reinforced on account of their exposed position. At the time of the closing down of the canal works, nineteen cribs had been successfully built and towed to Port Weller, eighteen of which had been sunk in place. The nineteenth had not been sunk in place when the time came to close down, but with valves open, and therefore ballasted with water, it safely rests on the harbor bottom, where it will, in all probability, remain until the resumption of activities. When

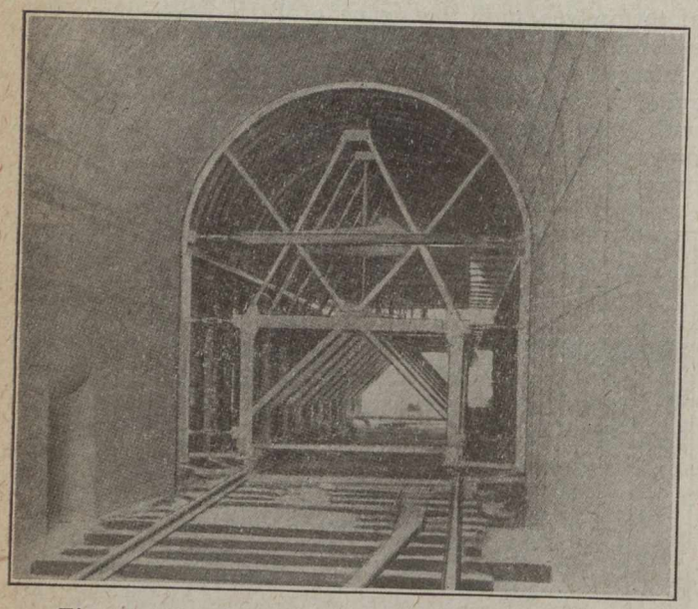


Fig. 2—Showing Collapsible Steel Form Used in Filling Culvert

all the cribs have been sunk in place, a superstructure of mass concrete will be built, to cover up irregularities in sinking, and bring the whole up to coping level, in true alignment.

Lock No. 1, Weirs and Guide Walls.—The whole of the concrete work in this section, other than cribwork, is being carried out by Lave Bros., Ltd., of Alta Vista, Va., U.S.A., sub-contractors of the Dominion Dredging Company. The earlier operations have already been described in this journal,** but it is now possible to show some of the finished work. Fig. 1 is a view of the reinforced concrete entrance wall to Lock No. 1, and shows back-filling operations in progress. The end of the wall, in the foreground, is located at a point near the present shore line, and will ultimately be connected up with the line of cribs forming part of the harbor of Port Weller. At the other end of this wall, which is 42 feet high, and which extends for a distance, south, of some 1,640 feet, is a section of gravity wall, 100 feet in length. These walls together form the entire approach to Lock No. 1.

Lock No. 1.—The lock walls are constructed in 60-foot monoliths, a metal cut-off being provided in the expansion joints between adjoining monoliths, extending from the bottom to the top of the wall, to prevent the passage of water when the joint opens. The main filling culverts are built into the wall by means of a collapsible steel form, 60 feet in length, and on the completion of a monolith to a height of 5 feet above the culvert, and after allowing a couple of days for setting of the concrete, the form is slightly collapsed, by means of turnbuckles, and moved forward on rails into position for the next monolith (see Fig. 2). Wooden forms are used for the laterals, connecting the main culvert with the lock. The lock is founded directly on the rock which was found at the required elevation. The rock, however, is a shale or mudstone, which, when exposed, shrinks and disintegrates, but retains its natural characteristics when kept continually wet. The contractors, therefore, were instructed to take proper, and definite, precautions, in order to make sure of a firm bond between the concrete floor of the lock, and the underlying rock. Fig. 3 gives a general view of Lock No. 1 looking north, but it should be noted that, since this photograph was taken, two or three of the 60-foot monoliths, referred to above, have been completed to cope level. Guide walls at the southern entrance to the lock have also been completed.

Bridges.—The substructure of two bridges is also included in the contract, one of which has been completed, viz., Bridge No. 2. They are both mass concrete structures, and rest on piled foundations.

General Progress of the Section.—It is estimated that upwards of 50 per cent. of the total work, called for in this contract, has been completed.

Section No. 2

Contractors.—Messrs. Baldry, Yerburgh & Hutchinson, of London, England.

Approximate Amount of Contract.—$5,200,000.

Work Contracted For.—Excavation of canal prism, and building of embankments, between certain points; construction of Locks Nos. 2 and 3, with entrance walls, weirs, etc.; substructure of Bridges Nos. 3, 4, and 5, and bridges over pondage at head of Lock No. 3, the whole section extending approximately 4⅓ miles.

Excavation.—The contractors commenced operations early in 1914, subsequently placing in operation four steam shovels, two dragline excavators, locomotives, dump cars, spreaders, graders, and traction engines, in order to cope with the work. Portions of the total work contracted for were also sublet to Yale & Reagan, Chicago, Ill.; Hill-Leonard Engineering and Construction Company, Toronto; and to Stein & Reade, Merriton, Ont. The construction of embankments was sublet to Michael Conroy, of Chicago, who placed in operation about 50 mule teams.

Lock No. 2.—This lock is located about 9,000 feet south of Lock No. 1, and in order to reach a stable foundation for the same, it was found necessary to excavate trenches 52 feet wide, averaging 17 feet in depth, below the general level of the lockpit, to the hard Medina shale. These trenches were then filled with concrete, in order to form a substantial sub-foundation for the main walls. An article entitled, "Grouting Under Canal Lock Wall Foundation," which appeared in this journal some time ago,† gives as an illustration, a typical general section through excavation and walls of Lock No. 2, and, so far as the general dimensions of the concrete are concerned, it is typical of all the locks on the canal.

Lock No. 3.—The site of this lock is about two and one-half miles south of Lock No. 2, and immediately north of the present canal, which the ship canal will cross at this point. The construction of the foundation is very similar to that of Lock No. 2, as conditions are similar, but beyond certain drilling and grouting, similar to that carried out in connection with Lock No. 2, only a small percentage of concrete has been poured, the con-

**The Canadian Engineer*, November 5, 1914.

†*The Canadian Engineer*, January 20, 1916.

tractors having decided to concentrate all their efforts on the construction of Lock No. 2.

Miscellaneous.—Sodding of canal banks and sides of drainage ditches has progressed, and some concrete protection to slopes of banks at the water line has been placed. The latter consists of a 6-inch slab of concrete laid on a layer of broken stone, and extends from 5 feet below water to 5 feet above water. The foot of the slab rests on a horizontal 5-foot beam, and has a 1¼ to 1 slope. The substructure of Bridge No. 4, which will carry the Queenston road over the canal at Homer, near St. Catharines, has been completed, but not back-filled. Some time ago a slip occurred at a little distance behind the east abutment, and the mass of earth, gathering momentum, it is imagined, caused undue pressure at the foot of this abutment, which rests on piling, and caused it to tilt forward from the vertical. At the present time there are three V-shaped openings, formed by the four monoliths comprising the abutment, which give a spreading appearance, after the manner of the spokes of a wheel. To all outward appearances this abutment will have to be re-constructed.

General Progress of the Section.—It is estimated that upwards of 50 per cent. of the total work called for in this contract, has been completed.

Section No. 3

Contractors.—Messrs. O'Brien & Doheny, and Quinlan & Robertson, of Montreal, Que.

Approximate Amount of Contract.—$9,500,000.

Work Contracted For.—Commencing where Section No. 2 leaves off, and continuing for a distance of about two miles, the work includes the excavation and removal of approximately 2,700,000 cubic yards of rock, and 3,400,000 cubic yards of earth; construction of twin locks in Flight Nos. 4, 5 and 6; single Lock No. 7, and masonry for guard gates, involving the placing of 1,250,000 cubic yards of concrete masonry; an earth dam with concrete corewall at head of flight of locks; diversion of Welland division and main line of Grand Trunk Railway; crushing and furnishing of about 1,000,000 tons of crushed stone to contractors for Sections Nos. 1 and 2; and other miscellaneous works.

Excavation.—A plant consisting of eight steam shovels to commence with, and subsequently ten, together with a large equipment of engines, dump cars, etc., soon began to make an impression, and when the order came to cease work, some 2,000,000 cubic yards of earth, and over 1,000,000 cubic yards of rock, had been removed. Judging by the figures given, it will be readily understood that with so much material overlying the site of the different locks, it would be a long time before much concrete could be placed. Over the site of Twin Locks No. 4, there was a large amount of clay to be removed, before coming to the rock, and after that, about 60 feet of solid rock excavation at the south end of the lock, diminishing to about 20 feet at the north end, to be negotiated. A considerable amount of this work is expected to be of a quality suitable for crushing for concrete, but unsuitable shale is required to be hauled to Lake Ontario, and deposited as stone protection along the slopes of the harbor embankment. The earth overlying the site of Twin Locks Nos. 5 and 6 has all been removed, and rock excavation has been going ahead since the early part of 1915. Upwards of 1,000,000 cubic yards of rock have thus been removed, the good rock being sent to the crushing plant,‡ or into storage piles, to be crushed later, and the unsuitable wasted in the valley of the ten-mile creek. Fig. 4 shows heavy rock cutting on site of flight locks, Section No. 3. From Twin Lock No. 6 to Single Lock No. 7 is a distance of 2,000 feet, and as but little excavation was required, excepting at the foot of Lock No. 7 where the rock crops up, this area has been utilized principally as a quarry for the excavation of large pieces of stone. The contractors for Section No. 3 quarry this stone, and load it on to cars supplied by the contractors for Sections Nos. 1 and 2, who haul it to their works, and use the stone as fillers, or "plums," in their concrete. Upwards of 70,000 tons of these "plums" have, so far, been excavated for use on Sections Nos. 1 and 2.

Concreting.—Comparatively little concreting has been done on this section, though during the season of 1915 some concreting was done on the upper entrance walls to Locks No. 6, and upper east entrance wall to Lock No. 7, and portions of the upper forebay walls of Locks No. 6, including some of the gate recesses, were built. But, as far as can be ascertained, little, or no, concrete was placed on Section No. 3 during the season of 1916.

Bridge No. 9.—The erection of the steel swing span, to carry the Niagara, St. Catharines and Toronto Railway over the canal, at the site of the guard gates, south of Thorold, under contract to the Hamilton Bridge Works Co., Ltd., was completed some time ago.

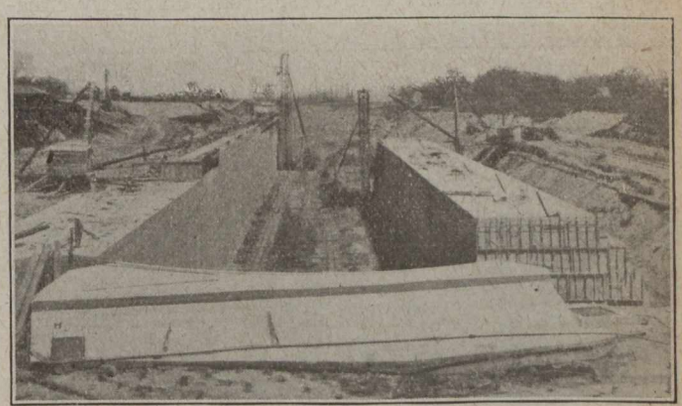


Fig. 3—Lock No. 1

Miscellaneous.—The construction of watertight embankments, to form pondage, at the head of Lock No. 7, have been completed, and also the two short reinforced concrete bridges, to carry existing roadways over the pondage, and sundry minor works, such as macadamizing of roads, fencing, etc.

General Progress of the Section.—It is estimated that about one-third of the whole contract has now been completed.

Section No. 4A

Contractors.—Messrs. Macguire & Cameron, St. Catharines, Ont.

Approximate Amount of Contract.—$80,000.

Work Contracted For.—This section consisted of two reinforced concrete culverts across the flats between the present and the old canals, north of Allanburg, and a supply weir, near Lock No. 25 of the present canal. They were to have been included in the contract for Section No. 4, but could not be deferred, when it was decided to postpone the letting of further general contracts. All the work under this contract was completed in 1915, and the structures brought into use.

Section No. 5

Contractors.—The Canadian Dredging Company, Limited, of Midland, Ont.

‡For particulars of crushing plant, see *The Canadian Engineer*, November 5, 1915.

Approximate Amount of Contract.—$1,950,000.

Work Contracted For.—Excavation of, approximately, 5,400,000 cubic yards of earth, and 75,000 cubic yards of rock; construction of concrete substructure for Bridge No. 13; concrete protection to banks, and other miscellaneous works.

This section covers that portion of the present canal through what is known as the "deep cut," between Allanburg and Port Robinson, which is to be widened on the west side, and deepened to the new dimensions.

General Progress of the Section.—Four steam shovels have accounted for the bulk of the dry excavation, in addition to which, there has been a dredging plant employed, consisting of three dipper dredges, one clam shell dredge, one 20-inch hydraulic dredge, and one drill boat, together with the necessary complement of tugs, scows, etc. The bulk of the excavated material is being disposed of on low-lying lands on the west side of the canal below Allanburg, including the bed of the old canal, by the aid of the hydraulic dredge. The material excavated by the dipper dredges, in widening and deepening the section, is dumped in front of the hydraulic dredge, which transfers it to these areas. The dry excavation is practically finished, and the remainder well advanced.

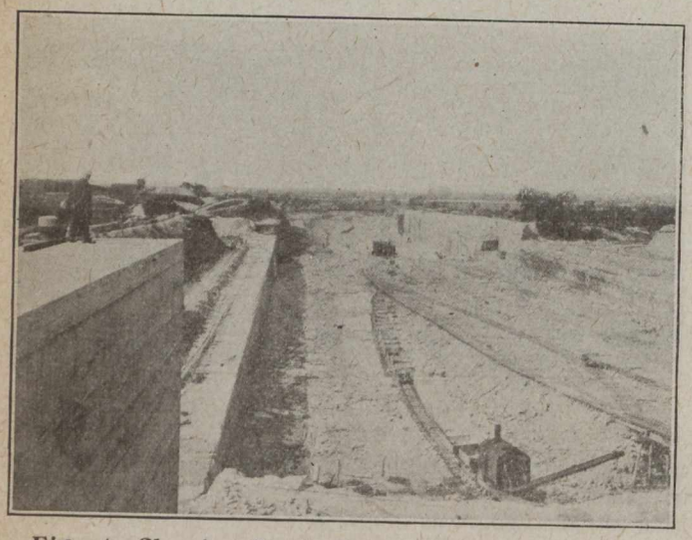


Fig. 4—Showing Rock Cutting on Site of Flight Locks, Section No. 3

General Remarks

Progress.—It is estimated that at least 50 per cent. of the total amount of work under contract was completed when operations were suspended.

Cement.—The contractor for each section was required to furnish all necessary materials of construction, with the exception of cement, which was supplied by the Department. In view of the large quantity of cement required, amounting to 2,500,000 barrels, it was considered advisable that a contract to cover the complete requirements during the life of the work should be entered into. Accordingly, tenders were invited by the Department, and a contract entered into, with the Canada Cement Company, for the supply of that amount, more or less, to be delivered as required, until the final completion of the work.

Sand.—For the greater part of the time, since the work commenced, the sand used on the different sections had been supplied by a sand company operating a pit near the village of St. Davids. The variable quality of the sand, however, had been such as to cause an endless amount of trouble to both engineer and contractors, with the result that a deposit of sand reported on at the mouth of the Niagara River, resulted in a new contract being made, to supply the different contractors with sand. A considerable quantity of this sand was found to be too fine for concrete work, but there was also a very large quantity of coarse, and eventually, in May, 1916, a contract was entered into with La Compagnie Générale d'Enterprises Publiques, of Levis, Quebec, for supply and delivery of same into a large bin specially erected on the harbor embankment at Port Weller.

Present Condition of Work.—The appearance of the canal site, after more than a year's exposure to the elements of unfinished work, is by no means discouraging. Beyond a scene of desolation, no material damage seems to have been sustained so far, beyond a little sliding away of some of the embankments and cuts. The chief damage done consists of the tilted bridge abutment, at the Queenston Crossing, on Section No. 2, referred to above. The construction railway has, to a great extent, been dismantled, and what was once one of the best-kept pieces of track to be found anywhere, is now a tangled mass of weeds. When the order to close down came along, the whole of the contractors' plant was required to be left on the ground pending further arrangements. When the contractors signed their agreements, they did so with the full knowledge and understanding that the Dominion Government had power to cancel those agreements, or otherwise discontinue the work before final completion, should it be deemed advisable to do so. But it is only reasonable to infer, however, that when the contracts were signed, neither party anticipated the contingency which has arisen. The Government authorities have already taken over the plant used on Sections Nos. 2 and 3, and settlements are being made, as rapidly as possible, in respect of all claims. Locomotives, cars, plant, and machinery of all kinds have already been sold and removed from the site, and a number of men are employed whose duty it is to take care of the plant still on the ground, so that it cannot be said that the action of the Government in terminating the work was, in any way, followed by neglect.

Conclusion

The step taken which resulted in the suspension of the work was well-nigh inevitable. The shortage of labor prevalent throughout the country had been felt by the contractors ever since the latter part of 1915, and, as time went on, it became more and more difficult to obtain, and hold, the requisite number of men for the successful prosecution of the work. The seductive wages offered by munition factories claimed many, overseas service claimed many more, and the contractors were not the only people connected with the undertaking who felt the strain. The engineering staff had been depleted by some sixty men, who had left for overseas service, and though a few substitutes were appointed, from time to time, it was with the utmost difficulty that pace was kept with the progress of the work. But with a continuance of united effort on the part of the Allied Army overseas, and the resulting peace which that effort must inevitably bring, it is not unreasonable to suggest that this great undertaking will, in the not too dim and distant future, be revived, and brought to a successful completion.

The whole of the above mentioned work was carried out under the direction of Mr. J. L. Weller, engineer in charge, for the Department of Railways and Canals, from whose reports many of the facts and figures quoted above have been obtained.

AN INTRODUCTION TO THE PHILOSOPHY OF SEWAGE IRRIGATION*

By James Craig

THE application to land of liquid sewage in a sufficiently mobile condition to gravitate is commonly known as sewage irrigation, and from the time of the introduction of sewers for conveying the sewage away from populated areas down to almost the close of the last century, irrigation of land was the system of disposal chiefly in vogue. But as our cities and towns cannot all comply with the idea of the worthy countryman who, after his first visit to London, being asked what he thought of it, replied, "That it was a fine place if it was out in the country," it is obvious that other considerations attract these congregations of the people, and the question of whether suitable land can be obtained for sewage irrigation comes as an afterthought and often debars the acquisition of sufficient or suitable land for sewage irrigation.

It is regrettable that many of the old sewage irrigation farms caused serious disappointment, and the regret has been emphasized greatly since the country has been at war and fertilizers have become almost unobtainable. The matter is further aggravated by the fact that in many cases the old sewage farm was looked at through financial spectacles rather than from a sanitary point of view, and the gulf was so great between the status of the man in charge and other officials with probably not more responsibility that failure was the natural corollary.

Choice of Site

In choosing a site for sewage irrigation the nature of the surface and subsoil is of great importance. An ideal formation would be a gravelly loam overlapping a coarse, gravelly subsoil; indeed, unless a sufficient area with means for extension of something approaching this type of land can be secured within reasonable distance of and altitude to the town and stream, other methods should be considered. Any land having impervious strata or clay formations within 3 feet 6 inches of the surface should be completely avoided for irrigation purposes.

As regards the contour, the nearer the site can resemble a slightly inclined plane, the better; but while an undulating surface is more costly to lay out and requires greater cost and skill to irrigate, the general principle of avoiding the path of least resistance in actually applying the sewage to the land holds good on most treatment areas.

The sewage should be delivered at a point of the irrigation area from which it can diverge by gravitation to the whole area and prospective extension areas. It will be found most convenient to have the system of distribution arranged so that the rate of flow per acre can be varied, enabling large or small sections of the area to be irrigated or rested as desired.

The conveying channels may be made of a variety of materials such as wooden or metal troughs, concrete channels, earthen channels, stoneware pipes, concrete tubes, cast-iron pipes, etc. These may be laid above or below ground, but the author considers that glazed stoneware pipes or concrete tubes thoroughly jointed and sufficiently underground to be protected from climatic influences answers the purpose admirably. Of course other carriers than main arteries may be advantageously formed in the soil itself unless a valley has to be crossed, when pipes laid on the syphonage principle would have to be resorted to in preference to carrying the liquor overhead in open or closed channels.

*Paper read before the Association of Managers of Sewage Disposal Works.

Distribution

The distribution of the sewage on to the land requires careful attention. With arable land the ordinary ridge and furrow method of distribution gives very good results as long as the sewage is allowed a fair velocity for 4 feet or 5 feet after entering the furrow. Then the velocity should be checked by means of small stanks made from the soil at distances apart to suit the gradient of the section being irrigated. These baffles can be made by spade or shovel, or an arrangement can be fixed on the ordinary horse hoe to do the work more expeditiously. Five-feet baulks are also suitable for arable land. Grass land and other broadcast-sown crops may be laid out with slight furrows further apart, but at distances and altitudes to ensure quick and thorough saturation of the surface. In most grades of irrigation land it will be found beneficial to the production and maintenance of a good effluent to have the underground drains laid parallel in preference to what is known as the "herring-bone" or lateral principle, and in the application of the sewage to the surface it should be conveyed, so far as is practicable, in a direction parallel to the underground system of drainage. Crossing over the line of an underground drain with furrows conveying sewage should be avoided, as this often causes percolation of polluted water directly to the drains and the polluting of an otherwise good effluent. Distribution is greatly aided by regular loosening of the surface of the ground; if it is allowed to form a crust, absorption is retarded, the sewage takes the path of least resistance and ponds in the lower places with often disastrous results as well as aerial and aqueous pollution.

Drains

For the purpose of laying underground drains for drawing off effluent the author is of opinion that these should be of an average depth of 4 feet 6 inches with a gradient of at least 1 in 1,000, and glazed socketed stoneware pipe drains laid parallel to each other and discharging into an intercepting drain which should be cement jointed with an effluent inspection chamber for each independent section of the land. The individual pipes of the collecting drains should be laid so that the spigot end only enters about half way into the socket—not forced tight up, as is done by many drainers with the back of the spade.

The trenches should be excavated sufficiently wide at the bottom to admit of 4 inches to 5 inches width of screened gravel or other clean, hard media being placed along each side of the pipes and over the top of the pipes to a depth of 12 inches, then placing new-cut turf inverted over the gravel or a thin layer of straw or fine brushwood to arrest the fine particles before getting to the pipes. The trenches require to be carefully filled and rammed. In running sand it would be found advisable to supplement this by placing a layer of fine brushwood in the trench before laying the pipes to prevent the fine particles getting into the pipes from underneath and filling them up.

The sewage should be subjected to sedimentation in tanks prior to being irrigated and the sludge removed from the tanks into storage lagoons until such time as the land is void of crops, when it can be carted, spread, and ploughed under preparatory to planting subsequent crops.

In conclusion it is only fair to say that an irrigation scheme with a sufficiency of good land carefully chosen, laid out and carefully managed, will give results which

will compare favorably with most other schemes in operation at the present time, and it has the casting balance of not adding materially to the waste of mineralized manurial constituents that are daily making their way from other systems to the ocean instead of producing useful vegetation and maintaining the cycle of change through which matter passes from living tissue to inorganic substances and thence to living tissue again.

MAINTENANCE OF ELECTRIC RAILWAY EQUIPMENT*

THE master mechanic or superintendent of equipment, who is the head of the department, should have the following men under him: Chief clerk, chief draftsman, chief inspector and the following foremen: foreman of car barns, machine shops, forge shop, car wiring and controller, armature room, carpenter shop and paint shop. Experience teaches that far better results can be obtained by having the department foremen report directly to the master mechanic than can be obtained where there is an intermediate official between the master mechanic and the department foremen. In addition to the organization above, there must be developed a system of inspection and general overhauling. The inspection is done in operating car houses under the supervision of the car barn foreman and the general overhauling done at the general shops under the supervision of the master mechanic. Inspection and general overhauling can either be done by a daily basis or on a mileage basis. For inspection, it is better to use the mileage basis, for the reason that it often happens that some particular car will make more mileage in three days than another car would make in five days. If the daily system were used, the car that made the large mileage would be under-inspected, and the one that made the small mileage would be over-inspected. If the mileage basis is used, an inspection should be made at from a 1,100 miles to 1,600 miles, depending on whether the equipment is old or modern. With the daily basis, the usual time between inspection is the seven-day period.

With inspection on the mileage basis, some of the cars are out 12 or 14 days between inspection, while others are only out six or eight. The main features that limit the mileage between inspection are adjustment of brakes, lubrication of motors and adjustment of controllers.

To take care of power, when an average number of 70 cars is operated from a barn requires one foreman, one carpenter, one controller man, one man on air and trolleys, two for brakes and bolts, two for oiling and inspecting motors and journals, a night foreman and two repairmen to look over bolts, brakes, and to correct any defects which the motormen might book on "defect cards."

In the operation of an electric railway system there are a number of things that can be put off or curtailed without serious results, but not so with the inspection. The inspection can be regulated so as to do work at the critical moment, but if you go by this point, the equipment is ruined and has to be renewed. For instance, the armature of a motor revolving between field pieces with 3/16 air draft has babbitted bearings. Should these bearings run hot, the armature rubs on pole pieces, ruining the armature, causing the expensive operation of rewinding the armature.

*Abstracted from paper read before the Pacific Railway Club.

Overhauling

An economical point for general overhauling equipment is the 50 to 60,000-mile period, or approximately every sixteen months. This is about the limit to the wear of wheels and bearings, and also an economical point to touch up and revarnish the car body.

While the car is being overhauled, testing also can be done. The first test should be the one on air reservoir. This can be done under hydraulic pressure without removing the reservoir from the car and before the car is taken inside the shops.

Before the trucks are dismantled they should be cleaned with a sand blast or other effective means so as to make inspection for flows more effective. Motors then should be removed by cranes, wheels removed and brake rigging dismantled. If possible, new wheels should be used in an overhauled car, and the wheels which are yet serviceable when the car is brought in should be reground and used for replacement when wheels are changed at the car barns. By the use of bushings, electric welding and oxyacetylene welding, the brakes, levers and castings can practically all be reclaimed. When overhauling motors, the armature should be removed and thoroughly inspected and tested. The field coils should be tested and terminals inspected, the inside of the motor should be cleaned and painted with waterproof paint. Back yoke and holders should be removed, cleaned and repaired. In assembling the motors, care should be taken that the liners do not bind and that the brush holders are properly set to give right space between brushes. The motor can then be mounted on the truck, and trucks are ready to be replaced under the car. The electricians in the meantime remove all main switches and braces, test them and renew worn parts. The controllers are thoroughly cleaned and adjusted and connections tested. New fingers should be used on an overhauled car and the old fingers that are not worn should be kept at the car house for further use.

Air compressors should be removed and dismantled, cleaned and inspected, and the gauges should be removed and reset by the master-governor. While this work is going on, the carpenters go over the wood work, and all crews should finish together in about three days' time. Painting, touching-up and revarnishing takes another six or seven days. With all departments working together, a car should not be in the general overhauling shops more than an average of two weeks in every sixteen months.

This is an outline of what should be done to the equipment, so as to give the passenger reasonable assurance of an uninterrupted ride and at a reasonable cost to the railway company.

An ingenious method of measuring the depth of sludge in deep sedimentation tanks is employed at the sewage disposal works of Fitchburg, Mass. The measurements are made by means of a pitcher pump and 28 ft. of 1-in. rubber hose, marked in 1-ft. lengths. The pump is screwed to a 3-ft. plank and attached to the hose by a union coupling. In making measurements the plank is placed across the top of a gas vent and the hose pushed into the tank until it is near the supposed sludge level. The hose is then lowered 2 inches at a time. Between each shift sufficient pumping is done to insure a complete change of water in the hose. When the sludge level is reached the pump will raise sludge. The length of the hose below the chimney top is then noted and as the distance from top of chimney to bottom of tank is known, it is an easy matter to calculate the depth of the sludge.

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

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

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

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

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

Principal Contents of this Issue

INDUSTRIAL EXPANSION AND THE VICTORY LOAN

CANADA'S remarkable business boom in the past year has been due to a large extent to the ability of the government to lend the necessary financial support to the Imperial Munitions Board, which has had the placing of orders amounting to over a billion dollars with Canadian manufacturers. Without this organizing and directing body, acting in co-operation with the Dominion government, Canada would not have received anything like the orders for munitions, ships, wheat, cheese and other commodities.

The Imperial Munitions Board, which grew out of the old Shell Committee, was entrusted with the buying of supplies, such as wheat, butter, cheese, ships, shells, airplanes and divers other commodities needed by the vast armies of Britain and her Allies, and because it was able—through the Victory Loan—to get advances from the Government, it immediately began to arouse the latent energies of this Dominion. Industries were established on a vast scale.

Contracts were given for 90 ships of the value of $25,000,000; a thousand manufacturers were set busy on war materials and supplies; airplane factories were built that have turned out many machines to date, while engines of the latest construction were manufactured in great numbers; the whole exportable supply of Canadian cheese was bought; the same with wheat; spruce forests were opened and contracts awarded for 250,000,000 feet of spruce and fir. This wood was required for airplanes, and a huge industry came to life in British Columbia to meet the demand. We have made millions of shells for the Board. These are the figures for shells and explosives alone: 60,000,000 shells of all sizes, 45,000,000 cartridge cases, 30,000,000 fuses, 65,000,000 pounds of powder, 50,000,000 pounds of high explosives, 1,800,000 tons of steel.

All this has meant money. The Imperial Munitions Board has placed orders to the amount of $1,200,000,000 in the Dominion. It has orders for the coming year amounting to $500,000,000. It has received advances from the Dominion government amounting to about $25,000,000 a month, and this has been poured back into the pockets of the artisans, the laborers, the manufacturers, the supply dealers. It has employed between 250,000 and 300,000 people, and 1,000 manufacturers have been kept busy supplying the needs of the war. At present there are 400 manufacturers in contractural relations with the board.

Our export of manufactures during the past year reached the colossal sum of $636,000,000. When we consider that in the year 1913 our export of manufactures amounted to only $43,000,000 we can form some idea of what the business created by the Imperial Munitions Board has meant to the people of Canada.

There is a lesson in all this. We cannot afford to allow the 1918 Victory Loan to be only a partial success. The more money at the disposal of the government the greater the business. The benefit is reaped by all the people.

AMERICAN WAR CONTRACTS

Among the general public the impression had prevailed that the volume of American contracts for shells and other war supplies, placed with Canadian manufacturers, was likely to increase during the remainder of 1918, and that the special war business thus derived from the neighboring country would perhaps go some distance in offsetting the decline in British orders. Some large American contracts were placed here quite recently, and it has been thought that others probably would follow in quick succession. Last week's statement of the War Industries Board at Washington, to the effect that the United States Government is discontinuing as rapidly as possible purchases of army supplies in foreign countries, apparently points in the opposite direction. It should be remembered, in this connection, that Great Britain has been supplying the American armies overseas with a large quantity of items needed by them which could not be provided quickly enough in the United States. The supplies purchased in Britain would be much greater in value than those contracted for in Canada.

In the course of this great war the need for this or that class of supplies often rises suddenly, and it cannot be postponed without endangering or injuring the military prospects. So, no matter how much the government in question may wish to further the interests of its home industries, it is forced, in many cases, to place its orders where there is assurance of expeditious completion. That is part of the explanation why Canadian manufacturers received extensive orders from Washington for shells, etc. They had their plants already equipped with the necessary machinery; the skilled labor was there; finally, they had an experience of two or more years in turning out similar products for Britain, and the American authorities knew they could depend upon getting goods that would measure up to the specifications. Under the circumstances, the shells being urgently needed and the Canadian facilities being there ready for use, Washington could not waste time waiting for numerous con-

cerns in the United States to convert their plants into munition works and experiment as regards filling the contracts.

It is generally supposed also that the United States Government was willing to do something to help Canada maintain the equilibrium of her exchange market. Ordinarily, assistance in regard to this detail is rendered through the agency of loans or credits. While the American Government has made direct loans to allied countries aggregating over $7,000,000,000 (Belgium, Cuba, France, Great Britain, Greece, Italy, Russia and Serbia participating in these loans), none has been made direct to Canada. So, by giving Canada war orders, it was possible to benefit her exchange position in the same way as if a direct loan had been made. Then, again, the United States authorities have permitted Britain to expend in Canada a part of the proceeds of loans secured at Washington. The total amount loaned to Great Britain since the United States entered the war is over $3,700,000,000; and apparently of the proceeds of these British loans granted during the year ended June 30th, 1918, $400,000,000 were expended in Canada. This, also, has helped Canada to surmount the exchange difficulties connected with her large trade balance due to the United States. As regards the American army contracts, it is likely that we shall continue to get a substantial share. With five or six million men under arms, it will assuredly be necessary to call upon Canada for some of the supplies.

PERSONALS

J. J. CARMENT has been appointed city manager of Kamloops, B.C.

G. J. MACKAY, B.A., assistant inspector of Industrial and Technical Education in Ontario, has resigned to accept the chair of Metallurgy at Queen's University, Kingston.

COLONEL J. S. DENNIS has been appointed Canadian Red Cross Comissioner for Siberia. Col. Dennis is familiar with conditions from residence in Russia. In civil life he is assistant to the president of the Canadian Pacific Railway. He is a past president of the Engineering Institute of Canada.

JOHN LESSARD, C.E., of the Department of Highways for the province of Quebec has been engaged in the survey of alternative routes for the Gouin Highway. It has been suggested that this road, instead of following the Gatineau River towards Wakefield, should pass through Ironside and Meach's Lake. It would thus pass through a beautiful lake country and avoid all railroad crossings.

BRIG.-GEN. JACK STEWART, the Canadian railway contractor, who has directed the building of so many strategic lines at the front, has been made Director-General of Construction for the British Army, and will have supreme direction over all railways, docks, etc. Brig.-Gen. Stewart's authority is thus greatly enlarged, as the supervision of docks in France will entail much extra labor.

C. A. JENNINGS, manager of the Chicago office of Wallace & Tiernan Co., has been commissioned a captain in the Quartermaster Corps, Maintenance and Repair Branch, Construction Division, with headquarters at Washington. Mr. Jennings was superintendent of the Bubbly Creek Filtration Plant from its inception in 1908 until two years ago. His work at Washington will be under Maj. George A. Johnson, and he will look after water supplies and sewage systems at the various cantonments.

LORD SHAUGHNESSY has resigned as president of the Canadian Pacific Railway and is succeeded by E. W. Beatty, vice-president. Lord Shaughnessy will retain the position of chairman of the board of directors. Sir George Bury retires from his office of vice-president on account of ill-health, and is succeeded by Grant Hall, who has been vice-president in charge of western lines. Lord Shaughnessy has been president of the Canadian Pacific Railway since June 12th, 1898, and is one of the best-known men in the British Empire. He joined the railroad in 1882 as general purchasing agent.

LANCE-CORPORAL HERBERT KEYS, after serving in France since the beginning of the war as an n.c.o. with the Canadian Engineers, is now in England qualifying for a comission, and has already successfully completed a large part of his work as a cadet at the C.E. Training Depot, Seaford. He is a son of Prof. D. R. Keys, of Avenue Road, and graduated from the University of Toronto with class '06. Since that time he followed his profession as an engineer in South America, British Columbia, and Northern Ontario, until going overseas with the 1st Contingent. He has been in France four years, and was reported wounded, but returned to duty last fall. Lieut. Norman Keys, M.C., of the P.P.C.L.I., and Mr. David Keys, who is working under the British Admiralty, are brothers.

OBITUARY

WM. MAHLON DAVIS, a well-known civil engineer, died in Ottawa last week. Mr. Davis was a graduate of Kingston Military College. He was, prior to going to the Pacific Coast a few years ago, city engineer of Woodstock, Ont.

METHOD OF WATER WASTE ELIMINATION IN A 100 PER CENT. METERED CITY

(Continued from page 346)

rate of consumption to the assumed standard of 20 per cent. of the average daily consumption.

It has been the Oak Park experience that in order to be most efficient, a water department must be under one head. That is, not only should the manager take care of the mechanical end of the water works system, but also the financial part. He should also inaugurate the policies. It is very difficult to handle complaints regarding high bills and to give satisfaction if the money is collected in one department, "shut-offs" for non-payment of bills are handled in another, and the bills are rendered in either of the foregoing or yet in a third one.

To a large extent water for the allied forces on the continent is obtained from wells. The British territory is underlaid with chalk, and it is necessary to sink driven wells from 150 ft. to 250 ft. to reach the level of saturation. With two shifts the drilling progress on a 6-in. hole varies from 20 ft. to 60 ft. a day, and the yield per well may range from 50 to 150 gallons per minute. In the Somme valley, British troops used river water, which was passed through purification plants mounted on barges. About four-fifths of the French army water supply in the region of Verdun was obtained from wells. Wells dug by hand, in addition to drilled wells, are also employed to some extent—one of them was put down to a depth of 65 ft. If time permits, these dug wells are lined for the upper 10 ft. or 12 ft., and a curb 2 ft. high is built around the top to prevent débris or waste water falling back into the well. For dug wells a round section about 4 ft. in diameter is common.